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PINTSCH GAS PLANT, MANHATTAN ELEVATED RAILROAD, NEW YORK.

During the fifteen years of its use in the United States, the Pintsch system of car lighting has met with remarkable success. This is due to the combination of efficiency in lighting and the employment of a gas which may be compressed and stored for transportation without material loss of illuminating power.

There are now about 85,000 railroad cars and over 4,000 locomotives using the system, and it is also applied with equal success in the lighting of buoys for marking channels in harbors and rivers. The buoy lights burn continuously from six to eight months, according to their size, without attention.

Pintsch gas is made from a high grade petroleum distillate, and is a fixed gas, which when compressed has an illuminating power six times as high as that of coal gas, known as "city gas," in the same condition. While city gas loses nearly all of its illuminating power by compression, Pintsch gas loses only about 10 per cent., and its candle power is about 65 when compressed to 14 atmospheres.

The process of manufacture liberates the gas from the oil, and it removes the tar and impurities by condensation and purification, after which the gas is compressed into storage tanks, and from them it is admitted to the distributing mains for charging the car reservoirs. In passing from the car reservoirs at a pressure of 12 atmospheres or less the gas goes through a regulator, which reduces the pressure to about one-third of an ounce per square inch at the burners, maintaining a steady, even flame, regardless of the varying pressure of the reservoir. It is a very ingenious device, and is one of the important parts of the system.

Forty Pintsch gas plants are now operated at the important railroad centers in the United States by the Pintsch Compressing Company. One of the largest of these has 30 miles of distributing mains, supplying 28 different railroads, and altogether these plants supply 1,200 Pullman, 500 Wagner and 10,800 passenger coaches on 110 different railroads. The plants are exceedingly compact and well arranged, the latest and most interesting being that installed 18 months ago at

159th St., New York City, for supplying daily 1,100 cars of the Manhattan Elevated Railroad.

The gas is made in a two-story, 50 by 65 feet, brick building, and the whole plant, aside from the distributing system, occupies a ground space of about 60 by 136 feet. Besides being the newest plant, this one is interesting because of improvements in the retorts, which give a greater capacity with two fires than was formerly had with thirty. It also permits of better control of the quality of the gas. In general, the plant consists of the oil storage tanks, holding the raw material, a 50-gallon supply tank elevated inside the retort house, the retorts, condenser, exhauster, washer, purifiers, meter, gas holder, compressors, store holders for the compressed gas, and, finally, the distribution system. Fig. 1 is an exterior view of the plant; Fig. 2 is a diagram showing the process from the beginning up to the compression; Fig. 3 is a plan of the first floor of the building; Fig. 4 is the oil ends, and Fig. 5 the gas ends of the retorts; Fig. 6 shows the condenser and purifiers in a room over the compressors; Fig. 7 is the exhauster; Fig. 8 the compressors, and Fig. 9 a view of the valve gear of one of the compressors.

The oil supply tanks are underground outside of the building, and have a capacity for 25,000 gallons. A small pump in the retort house raises the oil to the supply tank as it is required, and from there it is sent by gravity to the retorts through graduated valves. The small tank is used to keep down the amount of oil in the retort house to the lowest terms as a measure of safety.

Formerly the retorts for Pintsch gas were of iron, and the improvement is in the substitution of clay. Clay retorts have been used for the manufacture of coal gas, and also to some extent for oil gas, but never before in this manner for making the gas used for car lighting. Clay withstands heat better than iron, and it lasts longer, but it requires continuous service, and is adapted only to plants of large capacity. These retorts may be made three times as large as iron for the same expense, and are economical because of the possibility of using fewer fires for the same work. Their use was to a certain extent experimental in this case, and it is now an assured success.

The retorts are of D section, 3 inches thick and 20 feet long, with a mouthpiece and self-sealing lid on each end. They are laid horizontally in two benches of six retorts each, and are heated by two coke fires in regenerative furnaces 30 inches wide by 6 feet deep, so designed as to heat the retorts evenly from end to end. The stoking door is at the floor level and in the center of the brick work, the ash pits being below the floor.

The hot gases from the fire reach the central portions of the retorts first, where they are mixed with a supply of fresh, heated air, inducing further combustion, which is completed by further additions of air at the top of the combustion chamber. The products of total combustion are led through flues to the chimney, their heat being utilized to heat the secondary air supply already referred to.

The oil is conducted from the supply tank to each retort by a separate pipe, with special devices for controlling its flow. Two of these connections are shown in Fig. 2, the others being omitted for the sake of clearness. After entering the retort the oil passes to the front through a 2½-inch pipe laid along the bottom of the retort. At the end farthest from the entrance this pipe has a return bend connection to a 4-inch pipe leading along beside the 2½-inch pipe to a point near the entering end, from which the gas is sent to the front again through the open retort. These pipes in the retort are turned up into a vertical plane in Fig. 2 in order to show them in the engraving. In reality, they lie along the bottom of the retort. These vaporizing pipes cause the oil to heat gradually, and they are necessary in order to vaporize the oil before it comes into contact with the clay. The adjustment of the flow of oil to the temperature of the retorts is important and requires careful attention in order to give a uniform product.

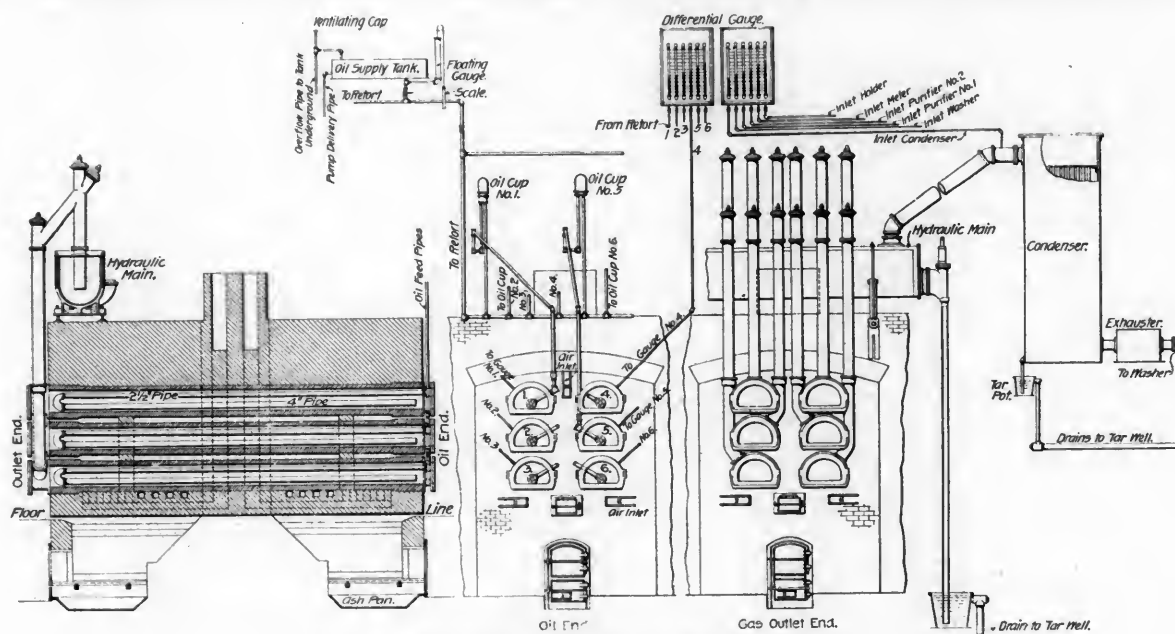


Fig. 2.—Showing Complete Gas Making Process.
(This Engraving Shows Process as far as the Washer. See opposite page.)



Fig. 1.—Exterior View of Plant.



Fig. 4.—Oil End of Retorts. Fig. 5.—Gas End of Retorts.



Fig. 6.—Condenser, Washer and Purifiers.

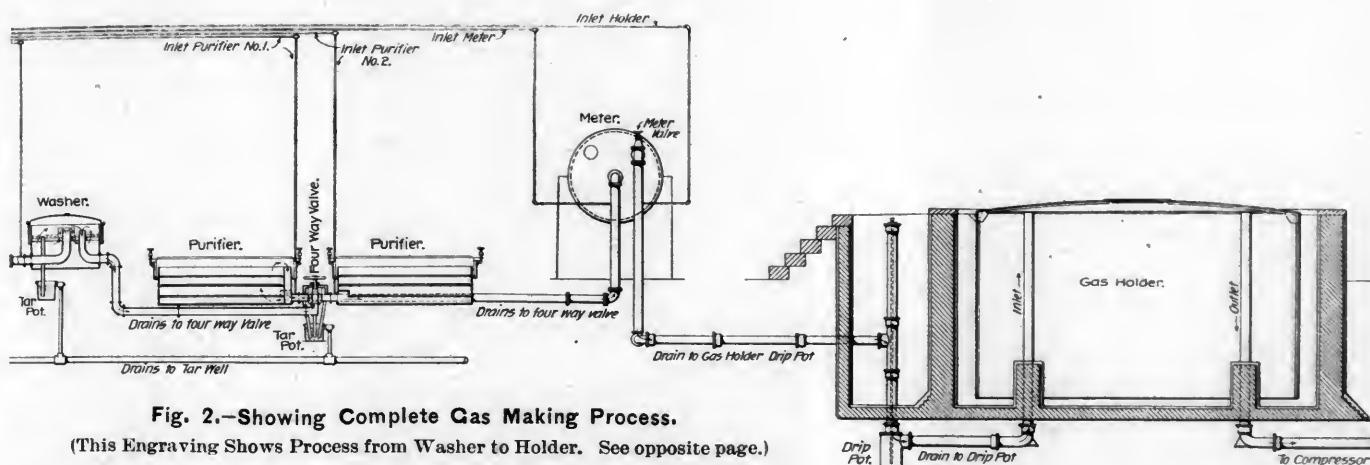


Fig. 2.—Showing Complete Gas Making Process.
(This Engraving Shows Process from Washer to Holder. See opposite page.)

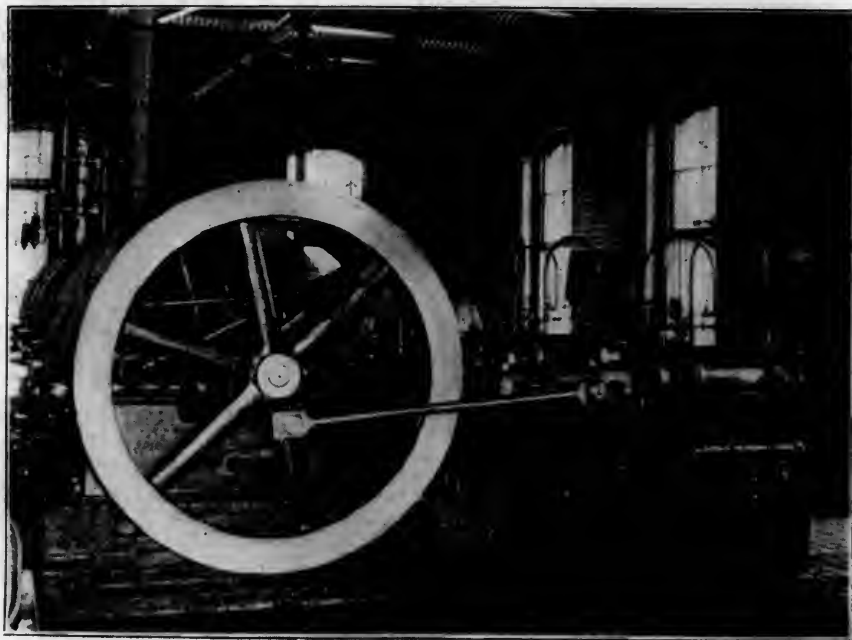


Fig. 8.—Compressors.

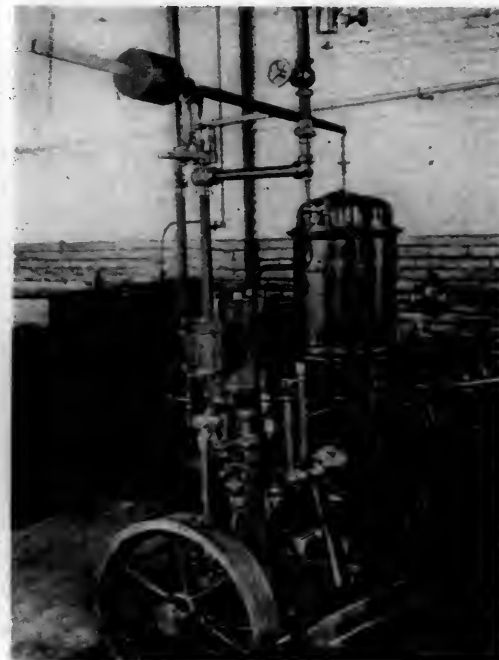


Fig. 7.—Exhauster.

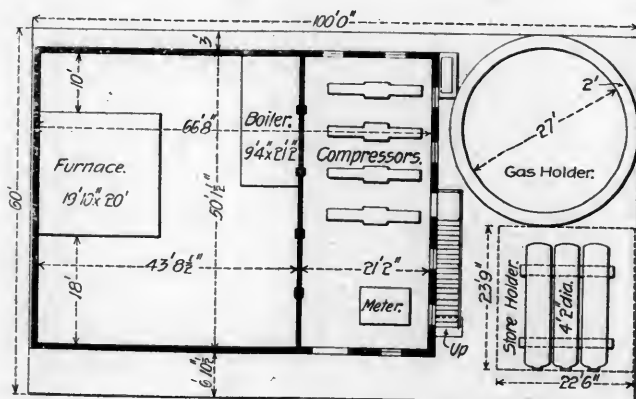


Fig. 3.—Plan of Ground Floor of Plant.



Fig. 9.—Simple Valve Gear of Compressors.

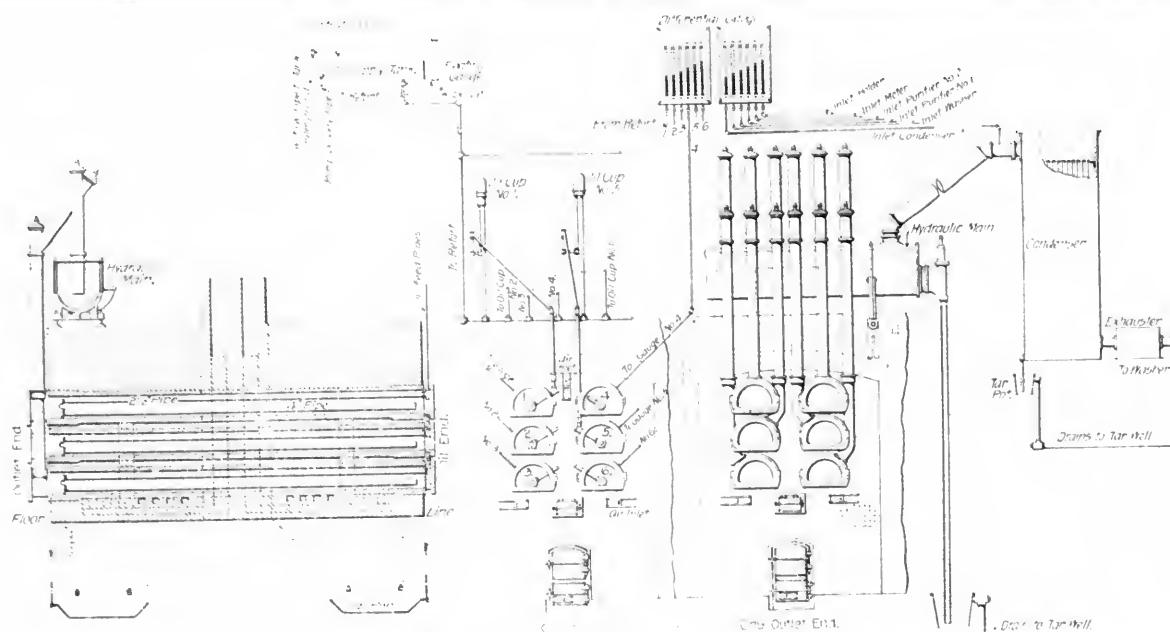


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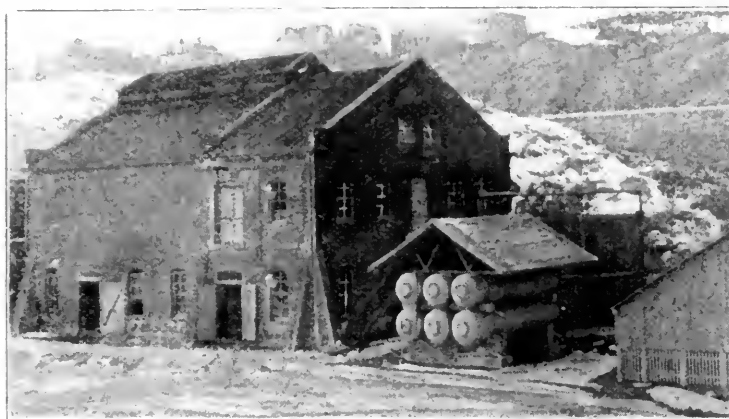


Fig. 1.—Exterior View of Plant.

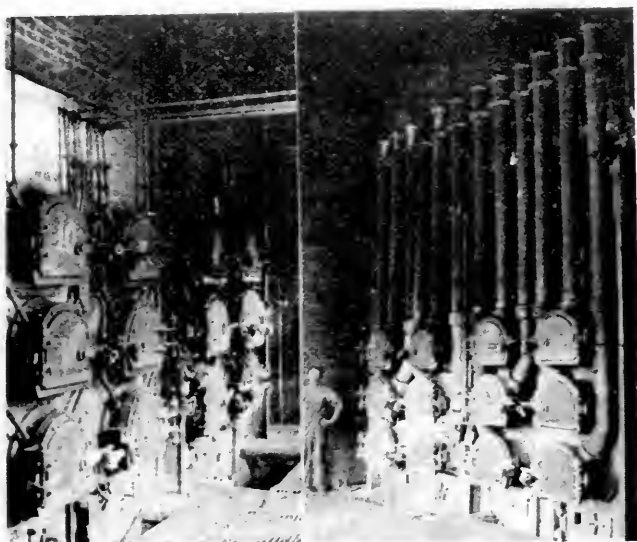


Fig. 4.—Oil End of Retorts. Fig. 5.—Gas End of Retorts.

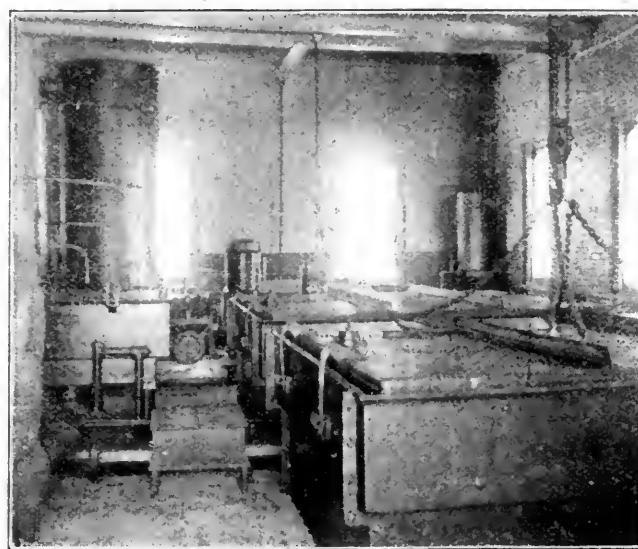


Fig. 6.—Condenser, Washer and Purifiers.

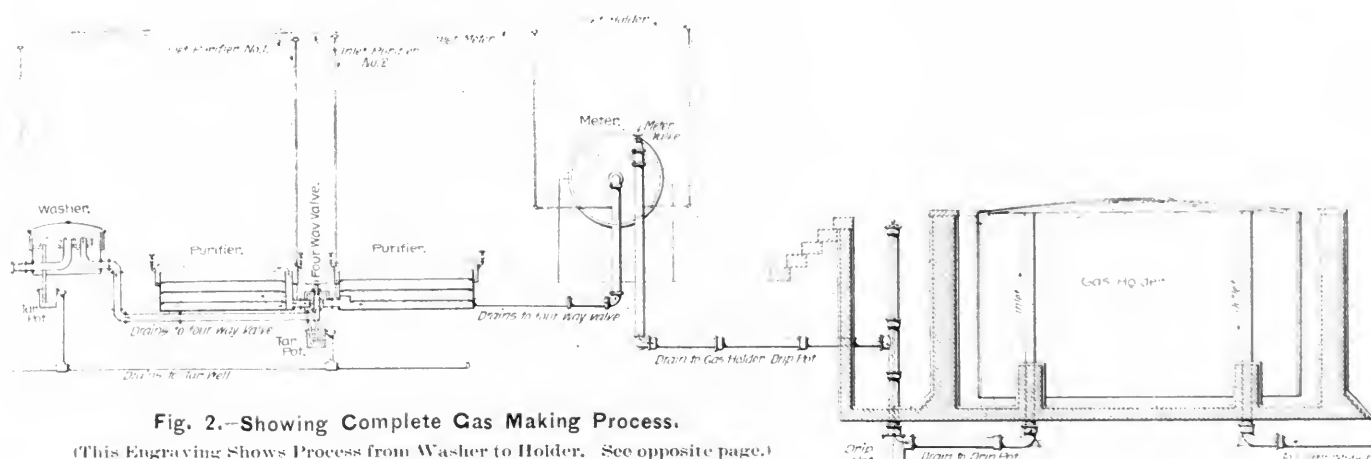


Fig. 2.—Showing Complete Gas Making Process.

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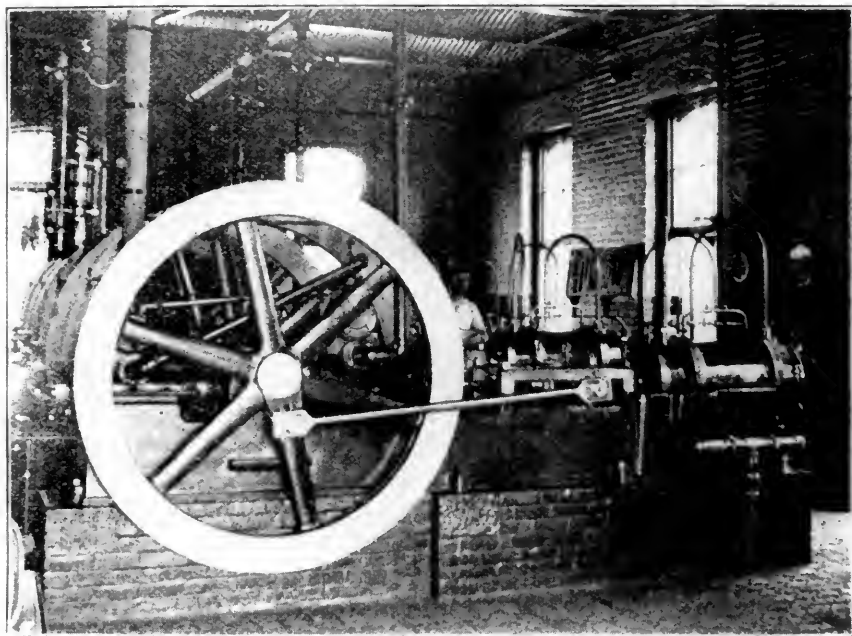


Fig. 8.—Compressors.

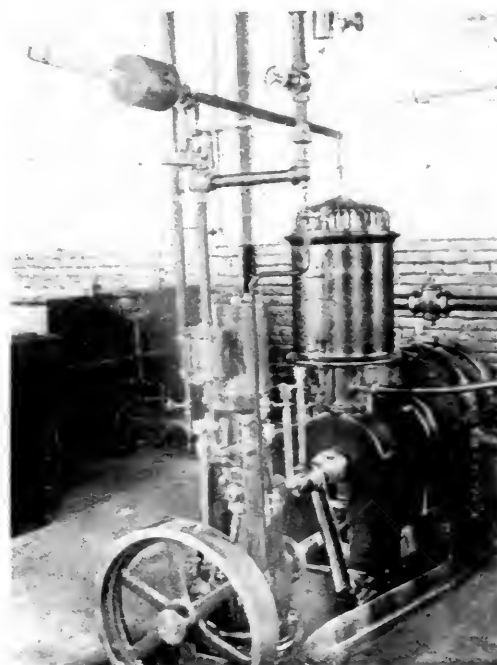


Fig. 7.—Exhauster.

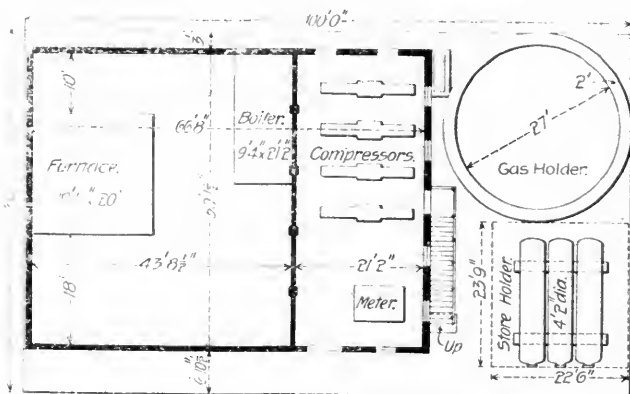


Fig. 3.—Plan of Ground Floor of Plant.

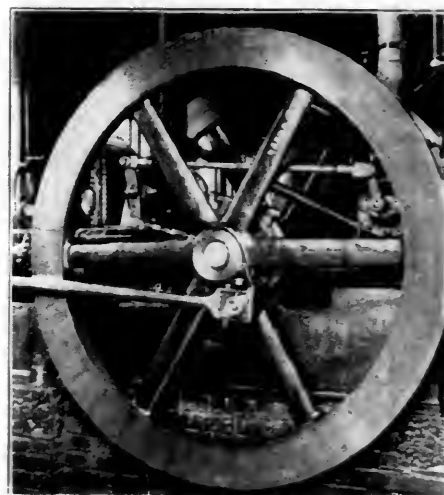


Fig. 9.—Simple Valve Gear of Compressors.

The gas leaves the front ends of the retort through 6-inch vertical cast-iron pipes, connecting each retort to the hydraulic main overhead. The gas passes into the hydraulic main through dip pipes, the ends of which are one inch below the surface of the accumulated tar, and thus serve to prevent any passage of gas back into an unused retort. The level of the tar is uniform, the surplus above that needed for the sealing of the pipes are being drained to a tank for storage. A safety valve, blowing off at 12 inches pressure, is connected to the end of the hydraulic main. A 10-inch pipe conducts the gas from the hydraulic main to the condenser in the purifying room located in the second story of the building. A running test for richness of the gas is applied by holding white paper before a jet from the standpipes leading from the retorts to the hydraulic main, the color of the stains made by the gas against the paper giving a measure of the quality of the gas.

In Fig. 2 the process of making gas may be followed. This engraving shows the system of pressure gauges, whereby the pressure at all points may be watched from the retorts.

The first step in the purification takes place in the condenser, which resembles a vertical tubular boiler, the gas passing inside and cold water outside of the tubes. It is seen at the left in Fig. 6. This removes all of the moisture and tar, and, in fact, everything that may be taken out of the gas by cooling. The tar and condensation drain off to the tar well. Fig. 6 shows the room in the second story of the building.

The use of clay retorts necessitates careful regulation of the pressure of the gas within them, and at this point in the process an ingenious and very effective exhaustor is employed, shown in Fig. 7. This is a rotary wing pump driven by a steam engine, the throttle of which is controlled by a regulator so sensitive that it will maintain a pressure of 1 inch of water at all times in the retorts. The clay will not permit more than this amount of pressure, which makes this machine one of the essentials of the clay retort system. The machine works admirably, being entirely automatic. The exhaustor passes the gas to the washer or scrubber, for removal of the products requiring mechanical operation. Here the gas is washed with water under a plate with ribs projecting downward, which cause the gas to bubble along in the water, finally passing through an outlet pipe to the purifiers. The washer is seen in front of the condenser in Fig. 6, and the purifiers are at the right, with the large covers, which may be lifted off by the chain hoists. In the purifiers the gas passes through large trays covered with lime or iron oxide for the removal of the sulphur. The gas then passes through a meter having a capacity of 8,000 cubic feet per hour, and goes to the gas holder outside of the building. It is then ready for compression, and at this stage tests of its quality are made by Hemple's method of absorption and by the photometer. The photometer room is well fitted up for testing the lighting power, a gas flame with a slit screen being used instead of standard candles.

The compressors, of which there are four, shown in Fig. 8, are excellent machines, worthy of a more extended description than the scope of this article permits. They were built by the Pintsch Compressing Company and are the outcome of long experience. The great care in the design and construction is manifested in their operation. A unique feature in the method of compressing at this plant is that it is done in two stages, with separate engines for each operation. This is done for the sake of economy in the number of machines and in the floor space required, as well as economy in operation. All of the compressors are compound, the steam cylinders being all alike, with 6 and 12 by 18-inch cylinders. The gas cylinders are 7 by 18 and 14 by 18 inches. The steam is distributed by D valves working on cylindrical surfaces and actuated by a single eccentric, an extremely simple valve motion (Fig. 9). The gas cylinders are water-cooled and have steel bushings. The inlet and outlet valves are in bonnets on the cylinder heads, and are accessible for inspection and renewal. The theoretical limit of the first compression is the square root of the total pressure,

and the first stage in this case is about $3\frac{1}{2}$ atmospheres, the pressure of the second stage being between 13 and 14 atmospheres.

The compression and cooling from the second stage deposits hydro-carbons, which are collected in pots outside of the building and under ground, from which they are sent to the small elevated tank in the right-hand corner of the purifying room by the pressure of the gas.

Steam is furnished by an 80 horse-power horizontal return tubular boiler, with a 75 horse-power submerged tube vertical boiler as a reserve.

After compression the gas is stored in five of the large welded steel store-holders shown at the right of the retort house in Fig. 1. The sixth of these holders is used as a reservoir or receiver between the low and high pressure compressors. Each of the store-holders has a capacity of 265 cubic feet per atmosphere.

The plant has a capacity of 150,000 cubic feet of gas per 24 hours, and is the largest of the kind ever installed. It is so arranged so as to provide for a reserve capacity of 100 per cent. for future extensions.

The piping system includes about 11 miles of extra strong 2-inch mains, all under a pressure of about 14 atmospheres. The mains have expansion bends, about a half mile apart, and are conducted along the elevated structure. In spite of the pressure and the extent of the line, there is a loss of less than 10 per cent.

The charging of the cars is done in five yards, and is performed with great rapidity by means of special hose fittings arranged for quick attachment and release. The chief charging stations are near the gas plant at 155th St., and at Second Ave. and 129th St. A pipe leads to the yard at 145th St. on Eighth and Sixth Aves., crossing over to Third Ave., where it returns to the 129th St. station for the Third and Second Ave. lines.

The car lamps with clusters of $\frac{3}{4}$ -foot burners give about 40 candle power each.

CAST IRON IN RAILWAY PRACTICE.

By G. R. Henderson, Mechanical Engineer, and W. Walley Davis, Chemist, Norfolk & Western Railway.

Cast iron is a much maligned metal, as far as engineering structures are concerned, but it is withal a very important one. Being one of the earliest forms in which iron was produced, it was used in places where to-day no one would think of suggesting it, until fatal accidents proclaimed it unsuitable for certain parts of important works, but, nevertheless, it is still an almost indispensable material in the great majority of engineering productions. Its utility being so great, it is necessary to carefully study its properties and composition, if we are to use it intelligently and without being considered reckless designers. A proper appreciation of the difficulties to be overcome and the needs of each particular casting will often enable us to make a very useful material out of this much abused metal.

For many uses in railroad work, such as most car castings, the cheaper grades of iron will answer, as well as for the thousand various pieces in which the shape is of more importance than the strength or wearing qualities. Such castings may be made largely from scrap, and the silicon will be low and the castings hard, but as they answer their purpose and cost but three-fourths of a cent per pound, we have no reason to complain.

In locomotives, a higher grade of iron is needed for cylinders, valves, driving wheel centres, driving boxes, etc. At the same time the metal must be such that it can be readily worked in the machine shop. Several years ago the writer, in endeavoring to provide a stronger metal than the ordinary run of cast iron for the purposes just enumerated, after some experimenting concluded that a metal produced by charging 20 per cent. No. 2 coke pig, 20 per cent. steel scrap (old

springs, sheet clippings, punchings, etc.) and 60 per cent. of cast iron scrap was suitable and available. Test bars demonstrated that this metal was about 20 per cent. stronger and 10 per cent. more flexible than the ordinary mixtures in use, and at the same time presented a good wearing surface—smooth and hard—without an undue amount of time spent in machining.

About the same time Mr. S. M. Vauclain, Superintendent of the Baldwin Locomotive Works, attacking the subject in a different way, produced a metal with similar characteristics and an almost identical analysis, as the following comparison will show:

Elements.	Our metal.	Vauclain's metal.
Graphitic carbon	2.45 per cent.	
Combined carbon	0.62	0.55
Silicon	1.51	1.47
Manganese	0.33	0.34
Phosphorus	0.65	0.65
Sulphur	0.063	0.10

(For details of these mixtures, etc., see page 208, Proceedings of Master Mechanics' Association for 1897.)

Perhaps the greatest care in selecting and grading the mixtures is required in the manufacture of car-wheels. For many years a guarantee of service was the only condition imposed upon the wheel-makers, but later the drop test was substituted by some companies for the guarantee. More recently the thermal test was introduced, thereby increasing the difficulties of the wheel-founder. While this test is considered by some as exceedingly severe, yet it is probably the nearest approach to service conditions that can be readily produced. It will be seen from the above that there are three principal features required of the wheels, namely—immunity from rapid wear, strength to resist shocks, and ability to withstand expansive strains due to abnormal heating of the rim. It has been considered by many that those elements in a chilling iron which tend to enhance the wearing qualities of a wheel are antagonistic to those required in order to successfully pass the drop and thermal tests. For example, it has been found from a series of carefully conducted experiments that manganese can be largely depended upon to give the wheel the requisite qualities to pass the thermal and drop tests, but this at the same time causes a reduction in the depth of the chill, consequently reducing the wearing qualities of the wheel. This will be explained more fully later on, being touched upon here as an illustration of the foregoing statement.

Mr. S. P. Bush, before the M. C. B. Association, last summer, in discussing the thermal tests for car wheels, gave a series of analyses to demonstrate the fact that the material in the plates or gray iron might vary considerably, yet it was possible to produce an almost identical carbon structure in the chilled portion.

This would tend to indicate that the form and not the amount of carbon determines the hardness of a chilled metal. What applies to the chill applies equally to the unchilled portion, the form of the combined carbon undoubtedly having a great bearing upon the character of the material.

In our examination of the subject there were upward of seventy car-wheels tested and analyzed. These were selected on account of failure to stand thermal or drop tests, or to give a respectable service under cars, or by reason of the fact that they had stood satisfactorily severe drop or thermal tests or had given an extended road service. In each case the chill was determined and a full analysis made of the metal in the plate.

Table No. 1 gives the information derived from these examinations.

In order to better study the problem, this information was reduced to a graphical representation illustrated by the diagrams, Figs. 1, 2 and 3.

The ordinates show the chemical composition of the different wheels, grouped according to their ability to stand test of service. In each diagram the poor wheels are grouped in the left hand column and the best wheels in right hand column. The variations in chemical composition are signif-

cant. These diagrams are shown in the form of zones, the lines for individual wheels being too fine to reproduce.

Examining first the graphitic carbon, in all the diagrams, the poor wheels are those low in this element, while the good wheels contain a large proportion of it. The combined carbon, as a rule, follows an inverse ratio. Silicon does not seem to take a very prominent part in affecting the physical properties of the wheels examined. As far as the thermal and drop tests are concerned, the amount of manganese is important; the greater the quantity the better the wheel stands the test. Large quantities of sulphur and phosphorus are, of course, objectionable, but within the limits in which they occur do not seem to affect the wheels particularly.

We give below a tabulated statement of the limits of different elements represented by the best wheels in each set of tests:

TABLE No. 1.

Throat chill.	Tread chill.	Drop blows.	Thermal test.	Service.	C. C.	G. C.	Si.	Mn.	S.	P.
1.12	56	24	0	....	.79	2.65	.72	.41	.06	.45
1.12	56	9	....	....	.63	2.87	.57	.33	.07	.41
1.12	56	9	....	8 1/2 yrs.	.66	2.75	.67	.31	.05	.35
1.12	56	60 min.	....	8 1/2 "	.61	3.19	.57	.34	.06	.31
1.12	56	0	....	7 1/2 "	.56	3.14	.72	.26	.07	.35
1.12	56	38 sec.	....	....	1.09	2.34	.71	.03	.08	.40
1.12	56	0	....	....	.50	3.21	.71	.40	.06	.37
1.12	56	0	....	....	.71	2.82	.74	.42	.06	.36
1.12	56	0	....	1 mo.	.99	2.66	.81	.29	.05	.44
1.12	56	10 min.	....	....	.55	3.31	.61	.43	.06	.36
1.12	56	0	....	....	.70	3.09	.52	.40	.06	.39
1.12	56	0	....	....	.60	3.28	.58	.30	.06	.37
1.12	56	0	....	....	.76	2.97	.69	.23	.07	.41
1.12	56	90 min.	....	5 yrs.	.81	2.80	.55	.27	.07	.49
1.12	56	0	....	2 mos.	.80	2.55	.84	.20	.07	.42
1.12	56	0	....	4 1/2 yrs.	.73	2.75	.56	.32	.08	.48
1.12	56	0	....	4 1/2 yrs.	.88	2.65	.59	.29	.06	.45
1.12	56	0	....	....	.79	2.48	.49	.51	.06	.44
1.12	56	0	....	....	.32	3.51	.62	.32	.06	.31
1.12	56	1 m. 20 sec.	....	1 1/2 yrs.	1.14	1.90	.74	.22	.12	.43
1.12	56	0	....	....	.73	2.46	.68	.22	.09	.43
1.12	56	0	....	1 mo.	.68	2.75	.56	.53	.05	.46
1.12	56	0	....	1 mo.	.99	2.45	.65	.15	.05	.40
1.12	56	0	....	1 mo.	1.05	2.35	.33	.16	.05	.39
1.12	56	0	....	....	.77	2.72	.54	.37	.07	.44
1.12	56	0	....	....	.76	2.65	.58	.44	.09	.44
1.12	56	0	....	....	.95	2.70	.67	.53	.09	.41
1.12	56	0	....	....	.65	2.74	.64	.46	.08	.43
1.12	56	0	....	5 mos.	1.12	2.29	.87	.22	.10	.39
1.12	56	0	....	5 mos.	1.42	1.96	.80	.29	.10	.41
1.12	56	0	....	5 mos.	.66	2.32	.62	.32	.10	.41
1.12	56	0	....	....	.63	2.72	.75	.45	.07	.45
1.12	56	0	....	....	.72	2.73	.51	.37	.07	.48
1.12	56	0	....	....	.73	2.83	.56	.39	.06	.44
1.12	56	0	....	....	.85	2.73	.71	.35	.07	.39
1.12	56	6 min.	....	....	.73	2.87	.66	.39	.06	.42
1.12	56	0	....	....	.66	2.83	.59	.43	.07	.52
1.12	56	0	....	....	.78	2.77	.61	.47	.07	.43
1.12	56	2 m. 5 s.	....	....	.90	2.74	.49	.47	.08	.43
1.12	56	0	....	8 mos.	1.40	2.12	.80	.15	.07	.44
1.12	56	0	....	4 mos.	1.40	2.21	.81	.12	.07	.37
1.12	56	0	....	5 mos.	1.40	2.07	.69	.16	.07	.44
1.12	56	Burst in mounting.	....	....	.47	2.94	.63	.39	.07	.44
1.12	56	0	....	....	.91	2.85	.58	.41	.04	.43
1.12	56	3 m. 5 s.	....	....	.81	2.62	.61	.28	.06	.40
1.12	56	0	....	....	.74	2.73	.67	.24	.05	.45
1.12	56	0	....	....	.79	2.85	.55	.25	.07	.45
1.12	56	Burst in mounting.	....	....	1.09	2.47	.55	.24	.06	.39
1.12	56	0	....	....	1.19	2.23	.55	.11	.08	.42
1.12	56	0	....	13 yrs.	1.25	2.33	.94	.13	.09	.32
1.12	56	0	....	1 yr.	.93	2.46	.56	.15	.06	.42
1.12	56	0	....	....	.65	2.82	.58	.25	.07	.43
1.12	56	Burst in mounting.	....	....	.55	3.14	.55	.36	.07	.43
1.12	56	90 min.	....	....	.33	2.99	.69	.29	.07	.48
1.12	56	90 min.	....	....	.46	3.07	.59	.31	.07	.49
1.12	56	0	....	6 mos.	.86	2.57	.62	.18	.06	.50
1.12	56	0	....	4 mos.	1.22	2.28	.63	.12	.06	.54
1.12	56	45 min.	....	....	.65	2.86	.71	.26	.07	.44
1.12	56	0	....	....	.58	2.94	.55	.22	.07	.39
1.12	56	50 min.	....	....	.73	2.90	.72	.28	.08	.44
1.12	56	60 min.	....	....	.70	2.80	.50	.21	.06	.39
1.12	56	0	....	10 mos.	1.06	2.72	.73	.19	.07	.43
1.12	56	0	....	1 mo.	1.18	2.31	.58	.13	.06	.41
1.12	56	0	....	4 1/2 yrs.	.65	2.90	.60	.16	.05	.39
1.12	56	0	....	....	.70	2.85	.68	.30	.07	.41
1.12	56	0	....	10 mos.	.96	2.48	.87	.20	.07	.49
1.12	56	0	....	4 1/2 yrs.	.65	3.05	.60	.27	.07	.44
1.12	56	0	....	....	.84	2.48	.49	.24	.08	.44
1.12	56	0	....	9 yrs.	.88	3.10	.58	.22	.06	.39
1.12	56	0	....	9 yrs.	.78	2.89	.60	.24	.06	.34
1.12	56	0	....	9 yrs.	.71	2.86	.68	.22	.08	.25
1.12	56	0	....	11 yrs.	.63	2.89	.66	.26	.07	.34
1.12	56	0	....	9 yrs.	1.01	2.56	.64	.18	.07	.39
1.12	56	0	....	10 yrs.	.77	2.91	.68	.27	.06	.45
1.12	56	0	....	8 yrs.	.66	2.84	.62	.15	.05	.43

"O" under "Thermal Test" means "did not crack." Samples taken from inner surface of rim towards the chill.

TABLE NO. 2.

(In per cent.)

Good Wheel Analysis.

	Thermal.		Drop.		Service.	
	Max.	Min.	Max.	Min.	Max.	Min.
G. C	3.28	2.65	3.31	2.65	3.18	2.23
C. C .....	.95	.32	.90	.55	1.24	.56
Si .....	.75	.50	.70	.50	.94	.58
Mn .....	.53	.20	.46	.24	.34	.13
S .....	.088	.055	.086	.040	.085	.047
P .....	.48	.35	.52	.36	.49	.25

These limits are naturally rather wide, but we give below what we consider the desirable limits for the chemical constituents in wheels.

TABLE NO. 3.

Desirable Wheel Analysis.

	Per cent.
Graphitic carbon	2.75 to 3.00
Combined carbon .....	.50 to .75
Manganese .....	.30 to .50
Silicon .....	.50 to .70
Sulphur .....	.05 to .07
Phosphorus .....	.35 to .45

The total carbon should run about 3.50 per cent., and the silicon and manganese together should make about .90 to 1.00 per cent.

In order to demonstrate that these limits apply to wheels which have given good service, we tabulate below in similar form the maximum and minimum limits of the last seven wheels in table No. 1, which gave from eight to eleven years' service:

TABLE NO. 4.

Limits of Good Wheels.

	Per cent.
Graphitic carbon	2.56 to 3.10
Combined carbon .....	.66 to 1.01
Silicon .....	.58 to 0.68
Manganese .....	.15 to 0.27
Sulphur .....	.05 to 0.08
Phosphorus	0.25 to 0.45

Out of twenty-two wheels in table No. 1 which cracked under thermal test in ten minutes or less, or did not give over two years' service, we find that all but one failed to come within the limits given in table No. 3. This would seem to indicate that this table would exclude wheels which did not have desirable proportions, and yet is well within the limits of wheels which will give good service and pass the thermal and drop tests.

The analyses given below, taken from the report of Mr. S. P. Bush to the Master Car Builders' Association last Summer, rather confirm table No. 3:

ANALYSIS OF THE GREY IRON.

Stood Thermal Test.
(In per cent.)

Total carbon.	Graphitic carbon.	Combined carbon.	Manganese.	Phosphorus.	Silicon.	Sulphur.
3.68	3.00	0.68	0.64	0.30	0.56	0.11
3.54	2.74	0.80	0.28	0.47	0.65	0.10
3.50	3.48	0.02	0.35	0.40	0.45	0.13
3.65	2.41	1.24	0.31	0.53	0.57	0.16
3.73	2.89	0.84	0.83	0.38	0.50	0.11
3.63	3.03	0.60	0.44	0.13	0.56	0.12
3.67	2.70	0.97	0.24	0.38	0.53	0.10
3.67	3.03	0.64	0.32	0.42	0.47	0.16
3.64	2.53	1.11	0.33	0.50	0.62	0.12
3.86	3.31	0.55	0.30	0.36	0.63	0.11

Did Not Stand Thermal Test.

Total carbon.	Graphitic carbon.	Combined carbon.	Manganese.	Phosphorus.	Silicon.	Sulphur.
3.64	2.41	1.23	0.30	0.35	0.71	0.14
3.22	1.98	1.24	0.34	0.51	0.77	0.16
3.51	2.56	0.95	0.31	0.44	0.75	0.12
3.64	2.30	1.34	0.21	0.39	0.65	0.13
3.61	2.52	1.09	0.17	0.35	0.60	0.11
3.61	2.94	0.67	0.33	0.42	0.79	0.12
3.73	2.60	1.13	0.23	0.35	0.66	0.11
3.68	2.54	1.14	0.19	0.39	0.88	0.12
3.74	2.57	1.17	0.30	0.41	0.60	0.13
3.45	2.39	1.06	0.40	0.36	0.68	0.19

Having developed what we consider the proper limits of the chemical constituents of wheels, it is necessary to determine which irons most readily fulfill these requirements. Twen-

ty-seven samples of charcoal irons were examined chemically and physically, and table No. 5 gives the results of analysis and transverse test. The analyses were taken from the pig, and the physical test made upon bars two inches square resting on supports 21 1-3 inches apart, the transverse load being applied at the center of the bar. The figures in the last two columns give the center breaking load, and the deflection just before breaking:

TABLE NO. 5.

Analyses of Charcoal Irons.

Ref. No.	Grade No.	C. C.	G. C.	Si.	Mn.	S.	P.	Centre Load.	Deflection.
		%	%	%	%	%	%	Lbs.	Inches.
1	4	1.70	2.23	0.42	0.37	Trace.	.30	8,000	.110
2	2	1.01	3.16	1.27	0.85	.005	.22	8,000	.170
3	4	0.66	3.01	0.51	0.55	.030	.37	8,500	.110
4	2	0.50	3.59	0.71	0.70	.011	.43	9,500	.170
5	2	0.70	3.12	0.76	0.33	Trace.	.22	8,500	.155
6	3	0.64	2.49	1.20	0.30	.003	.23	12,500	.205
7	4	0.73	2.29	1.50	1.17	.030	.41	14,000	.220
8	4½	0.67	2.21	0.89	0.86	.031	.38	16,000	.240
9	4	0.92	2.46	0.83	0.84	.015	.36	14,000	.220
10	2	0.65	2.96	1.62	1.22	.004	.41	9,500	.200
11	4	0.91	2.87	0.70	0.24	.005	.19	8,000	.130
12	2	0.59	2.88	0.39	0.15	.005	.23	7,500	.070
13	4	0.21	3.39	1.27	0.53	.004	.27	8,500	.210
14	3	0.48	3.56	0.46	0.31	.008	.44	8,700	.130
15	2	0.73	3.13	0.79	0.44	.031	.41	11,000	.140
16	3	1.32	2.41	0.93	0.50	.012	.33	10,500	.205
17	2	0.47	2.95	1.41	0.62	.016	.33	9,000	.200
18	3	0.32	2.24	2.30	0.45	.025	.27	14,000	.190
19	4	0.75	2.11	1.73	0.87	.037	.33	13,500	.190
20	2	0.49	2.31	1.75	0.61	.032	.31	15,000	.240
21	4	0.82	2.57	0.37	0.27	.011	.43	9,000	.100
22	5	1.00	1.93	0.39	0.32	.006	.36	6,000	.070
23	3	0.48	3.01	1.06	1.10	.008	.33	9,500	.190
24	2	0.91	3.15	1.32	1.25	.005	.37	9,500	.210
25	4	0.84	2.77	0.76	0.60	.011	.66	13,500	.220
26	4	1.56	1.81	0.90	0.10	.013	.35	7,800	.090
27	3	1.10	2.50	1.01	0.19	.021	.46	12,000	.205

For obvious reasons the names of the furnaces have been omitted, but examination of the last two columns indicates that Nos. 6, 7, 8, 9, 18, 19, 20 and 25 are particularly suitable, whereas Nos. 1, 2, 3, 4, 5, 11, 12, 13, 14, 21 and 26 are noticeably weak and unsuitable.

Fig. 4 is a photographic representation of the depth of chill and appearance of fracture of the chilled test bars. These bars were 2 inches square, and the scale at the top affords a means of measuring the amount of chill. It is considered better for the white iron to blend gradually with the gray, and the photograph shows plainly which irons are most perfect in this respect. This engraving may be used to select irons by their chill, and as the results are from bars made by remelting from the pig, nearly the same amount of chill may be expected in the wheel.

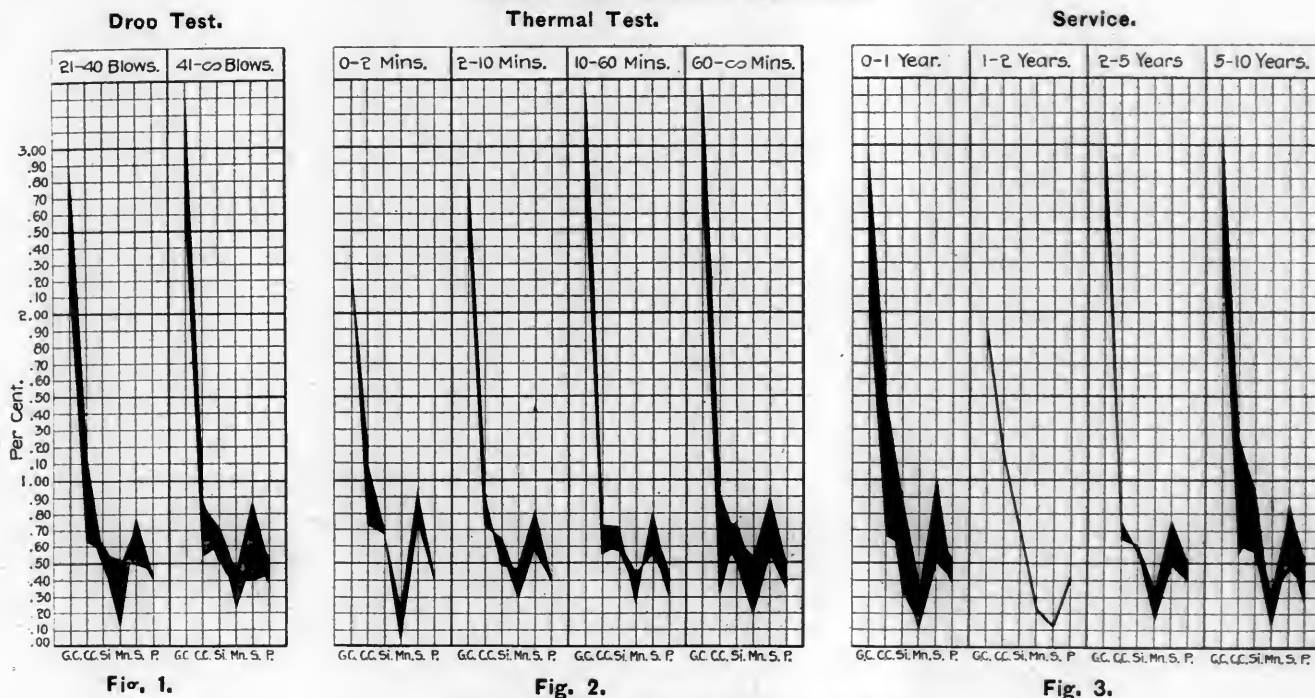
There should be at all times a sufficient variety of irons in stock to enable the founder to quickly and easily adjust his charges to rectify any local disturbance in the cupola or blast, or variations in the shipments of iron. This can only be done intelligently by having a complete knowledge of the properties of the various irons in stock, and to this end all shipments should be carefully analyzed. New or doubtful irons should also have physical tests made and recorded. As certain elements change their form in the cupola, it is necessary to charge the furnace so as to allow for this. Thus, if we desire wheel metal in accordance with our suggested proportions, we should proceed as indicated below:

Analysis.	Metal desired.	Metal charged.
Graphitic carbon	2.80 per cent.	3.07 per cent.
Combined carbon .....	.70 "	.50 "
Silicon .....	.60 "	.65 "
Manganese .....	.40 "	.50 "

The proportions to be used can only be determined by experience, and by constantly watching and testing the output.

The use of scrap always causes an amount of uncertainty. If the scrap wheels are entirely our own make, some dependence can be placed upon their composition, but this is seldom possible. The only practicable way to grade old wheels seems to be by the fracture, when breaking them under the drop. If a chemical analysis could be had, there would be little doubt about them, but this is not feasible. For this

TESTS AND SERVICE RECORDS.



Note.—The sulphur is shown ten times too large.

CAST IRON IN RAILWAY PRACTICE.



Fig. 4.—Showing Appearance of Fractures of Chilled Test Bars.

CAST IRON IN RAILWAY PRACTICE.

reason it is essential for the founder to be posted as to the properties of his output.

Manganese, more than any other one element, seems to be responsible for the capacity of the wheel to stand the thermal and drop tests. There is a great variation in the proportion of manganese even in different shipments of the same iron, and particularly is this true of scrap wheels.

In order to stand heating and blows, it seems essential that one-quarter of one per cent. of manganese should be present. Besides, there is always a loss of manganese in melting, so that a considerable quantity in the mixture is the more important. The practice of adding ferro-manganese to the ladle

has been followed in many foundries with very satisfactory results.

Ferro-manganese, however, reduces the chill, and it is, therefore, necessary to use more iron of the high numbers in the mixture. It brings about this effect by changing some of the combined carbon into graphitic, thus softening the metal. This must all be allowed for in charging the cupola.

A set of experiments were conducted in order to determine this effect of ferro-manganese. A ladle full of the regular wheel mixture was used to fill smaller ladles containing different proportions of the ferro-manganese, of approximately the following analysis;

TABLE NO. 2.

(In per cent.)

Good Wheel Analysis.

	Thermal.		Drop.		Service.	
	Max.	Min.	Max.	Min.	Max.	Min.
C, C	3.28	2.65	3.31	2.65	3.18	2.23
Si .....	.95	.32	.90	.35	.81	.36
Mn .....	.75	.50	.70	.50	.61	.38
S .....	.53	.20	.46	.21	.34	.13
P .....	.088	.055	.086	.040	.085	.047
P .....	.18	.35	.52	.36	.49	.25

These limits are naturally rather wide, but we give below what we consider the desirable limits for the chemical constituents in wheels.

TABLE NO. 3.

Desirable Wheel Analysis.

	Per cent.
Graphitic carbon	2.75 to 3.00
Combined carbon .....	.50 to .75
Manganese .....	.50 to .70
Silicon .....	.50 to .70
Sulphur .....	.05 to .07
Phosphorus .....	.35 to .45

The total carbon should run about 3.50 per cent., and the silicon and manganese together should make about .90 to 1.00 per cent.

In order to demonstrate that these limits apply to wheels which have given good service, we tabulate below in similar form the maximum and minimum limits of the last seven wheels in table No. 1, which gave from eight to eleven years' service:

TABLE NO. 4.

Limits of Good Wheels.

	Per cent.
Graphitic carbon	2.50 to 3.10
Combined carbon .....	.60 to 1.01
Silicon .....	.58 to .68
Manganese .....	.15 to .27
Sulphur .....	.05 to .08
Phosphorus .....	.025 to .045

Out of twenty-two wheels in table No. 1 which cracked under thermal test in ten minutes or less, or did not give over two years' service, we find that all but one failed to come within the limits given in table No. 3. This would seem to indicate that this table would exclude wheels which did not have desirable proportions, and yet is well within the limits of wheels which will give good service and pass the thermal and drop tests.

The analyses given below, taken from the report of Mr. S. P. Bush to the Master Car Builders' Association last Summer, rather confirm table No. 3:

ANALYSIS OF THE GREY IRON.

Stood Thermal Test.
(In per cent.)

Total carbon.	Graphitic carbon.	Combined carbon.	Manganese.	Phosphorus.	Silicon.	Sulphur.
3.68	3.00	0.68	0.61	0.30	0.56	0.11
3.51	2.74	0.80	0.28	0.17	0.65	0.10
3.50	3.48	0.02	0.35	0.10	0.45	0.13
3.65	2.11	1.21	0.31	0.53	0.57	0.16
3.73	2.80	0.81	0.83	0.38	0.50	0.11
3.63	3.03	0.60	0.11	0.13	0.56	0.12
3.67	2.70	0.97	0.21	0.38	0.53	0.10
3.67	3.03	0.64	0.32	0.42	0.47	0.16
3.64	2.53	1.11	0.33	0.50	0.62	0.12
3.86	3.31	0.55	0.30	0.36	0.63	0.11

Did Not Stand Thermal Test.

Total carbon.	Graphitic carbon.	Combined carbon.	Manganese.	Phosphorus.	Silicon.	Sulphur.
3.64	2.41	1.22	0.30	0.35	0.71	0.14
3.22	1.98	1.24	0.31	0.51	0.77	0.16
3.51	2.56	0.95	0.31	0.11	0.75	0.12
3.64	2.30	1.31	0.21	0.39	0.65	0.13
3.61	2.52	1.09	0.17	0.35	0.60	0.11
3.61	2.91	0.67	0.33	0.12	0.79	0.12
3.73	2.60	1.13	0.23	0.35	0.66	0.11
3.68	2.51	1.11	0.19	0.39	0.88	0.12
3.74	2.57	1.17	0.30	0.41	0.60	0.13
3.45	2.39	1.06	0.10	0.36	0.68	0.19

Having developed what we consider the proper limits of the chemical constituents of wheels, it is necessary to determine which irons most readily fulfill these requirements. Twen-

ty-seven samples of charcoal irons were examined chemically and physically, and table No. 5 gives the results of analysis and transverse test. The analyses were taken from the pig, and the physical test made upon bars two inches square resting on supports 21 1-3 inches apart, the transverse load being applied at the center of the bar. The figures in the last two columns give the center breaking load, and the deflection just before breaking:

TABLE NO. 5.

Analyses of Charcoal Irons.

Ref. No.	Grade No.	C, C.	C, C.	Si.	Mn.	P.	Center Load.	Deflection.
1	1	1.70	2.23	0.12	0.35	Trace.	11,000	.110
2	2	1.01	3.16	1.25	0.55	.005	8,000	.170
3	3	0.66	3.01	0.51	0.55	.030	8,500	.110
4	4	0.50	3.50	0.71	0.70	.011	9,500	.170
5	5	0.70	3.12	0.76	0.33	Trace.	8,500	.155
6	6	0.61	2.19	1.20	0.30	.003	12,500	.205
7	7	0.73	2.29	1.50	1.17	.030	11,000	.220
8	8	0.67	2.21	0.89	0.86	.031	16,000	.240
9	9	0.32	2.46	0.83	0.81	.015	11,000	.220
10	10	0.65	2.96	1.62	1.52	.001	9,500	.200
11	11	0.91	2.87	0.70	0.21	.005	8,000	.130
12	12	0.59	2.88	0.39	0.15	.005	7,500	.070
13	13	0.21	3.39	1.27	0.33	.001	8,500	.210
14	14	0.18	3.56	0.16	0.31	.008	8,700	.130
15	15	0.73	3.13	0.79	0.11	.031	11,000	.110
16	16	1.32	2.11	0.93	0.50	.012	10,500	.205
17	17	0.47	2.95	1.11	0.62	.016	9,000	.200
18	18	0.32	2.24	2.30	1.15	.025	11,000	.200
19	19	0.75	2.11	1.73	0.87	.037	13,500	.190
20	20	0.49	2.31	1.75	0.61	.032	15,000	.210
21	21	0.82	2.57	0.37	0.27	.011	9,000	.100
22	22	1.09	1.93	0.39	0.32	.005	6,000	.070
23	23	0.48	3.01	1.06	1.10	.008	9,500	.190
24	24	0.91	3.15	1.32	1.25	.005	9,500	.210
25	25	0.84	2.77	0.76	0.60	.011	13,500	.220
26	26	1.56	1.81	0.90	0.10	.013	7,800	.090
27	27	1.10	2.50	1.01	0.19	.021	12,000	.205

For obvious reasons the names of the furnaces have been omitted, but examination of the last two columns indicates that Nos. 6, 7, 8, 9, 18, 19, 20 and 25 are particularly suitable, whereas Nos. 1, 2, 3, 4, 5, 11, 12, 13, 14, 21 and 26 are noticeably weak and unsuitable.

Fig. 4 is a photographic representation of the depth of chill and appearance of fracture of the chilled test bars. These bars were 2 inches square, and the scale at the top affords a means of measuring the amount of chill. It is considered better for the white iron to blend gradually with the gray, and the photograph shows plainly which irons are most perfect in this respect. This engraving may be used to select irons by their chill, and as the results are from bars made by remelting from the pig, nearly the same amount of chill may be expected in the wheel.

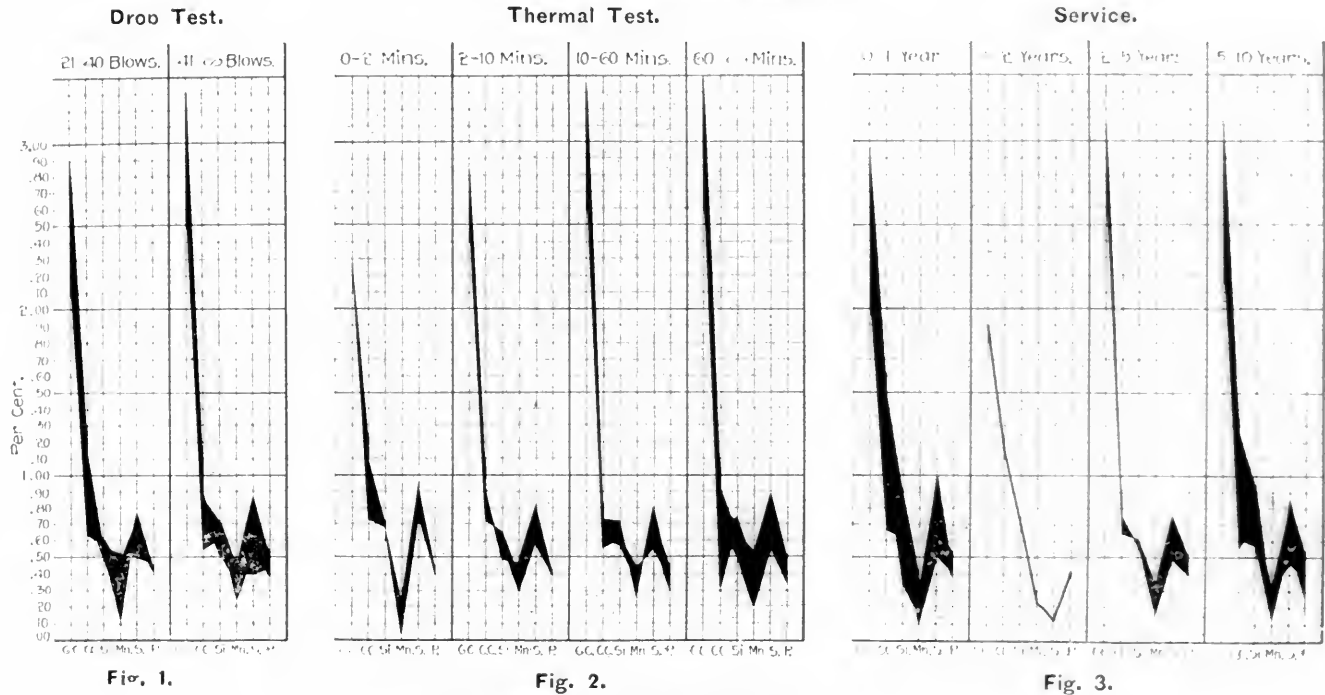
There should be at all times a sufficient variety of irons in stock to enable the founder to quickly and easily adjust his charges to rectify any local disturbance in the cupola or blast, or variations in the shipments of iron. This can only be done intelligently by having a complete knowledge of the properties of the various irons in stock, and to this end all shipments should be carefully analyzed. New or doubtful irons should also have physical tests made and recorded. As certain elements change their form in the cupola, it is necessary to charge the furnace so as to allow for this. Thus, if we desire wheel metal in accordance with our suggested proportions, we should proceed as indicated below:

Analysis.	Metal desired.	Metal charged.
Graphitic carbon	2.80 per cent.	3.00 per cent.
Combined carbon .....	.70 "	.50 "
Silicon .....	.60 "	.65 "
Manganese .....	.40 "	.50 "

The proportions to be used can only be determined by experience, and by constantly watching and testing the output.

The use of scrap always causes an amount of uncertainty. If the scrap wheels are entirely our own make, some dependence can be placed upon their composition, but this is seldom possible. The only practicable way to grade old wheels seems to be by the fracture, when breaking them under the drop. If a chemical analysis could be had, there would be little doubt about them, but this is not feasible. For this

TESTS AND SERVICE RECORDS.



Note.—The sulphur is shown ten times too large.

CAST IRON IN RAILWAY PRACTICE.

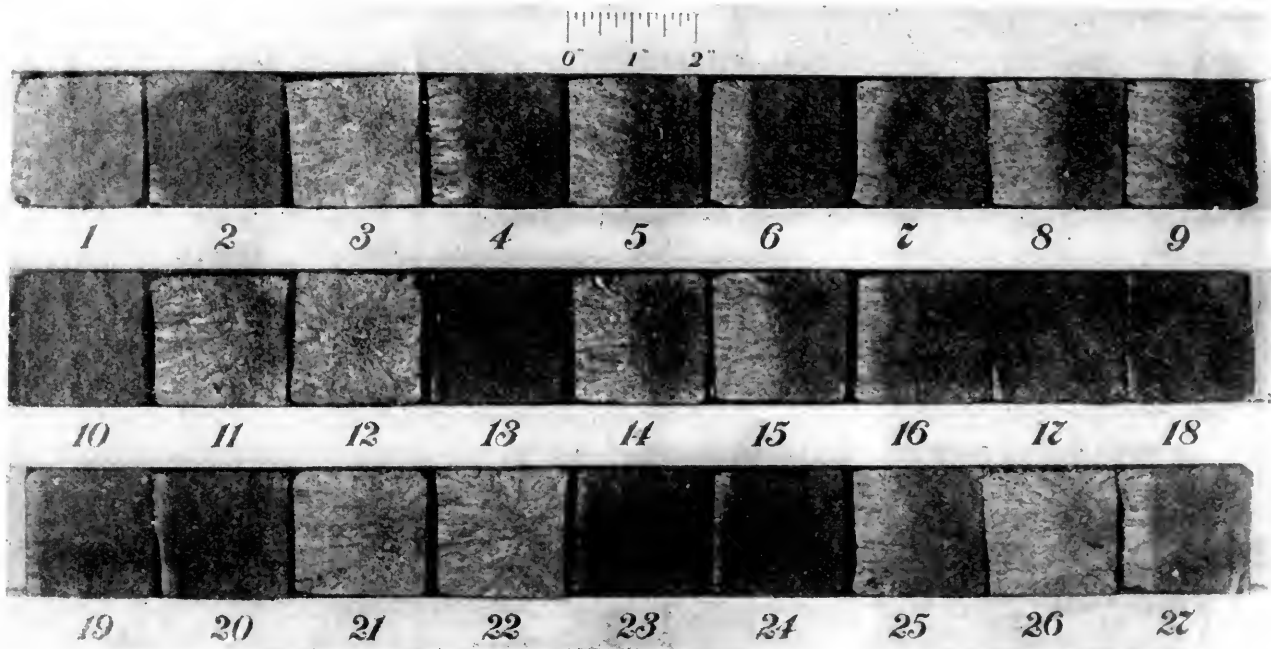


Fig. 4.—Showing Appearance of Fractures of Chilled Test Bars.

CAST IRON IN RAILWAY PRACTICE.

reason it is essential for the founder to be posted as to the properties of his output.

Manganese, more than any other one element, seems to be responsible for the capacity of the wheel to stand the thermal and drop tests. There is a great variation in the proportion of manganese even in different shipments of the same iron, and particularly is this true of scrap wheels.

In order to stand heating and blows, it seems essential that one-quarter of one per cent. of manganese should be present. Besides, there is always a loss of manganese in melting, so that a considerable quantity in the mixture is the more important. The practice of adding ferro-manganese to the ladle

has been followed in many foundries with very satisfactory results.

Ferro-manganese, however, reduces the chill, and it is, therefore, necessary to use more iron of the high numbers in the mixture. It brings about this effect by changing some of the combined carbon into graphitic, thus softening the metal. This must all be allowed for in charging the cupola.

A set of experiments were conducted in order to determine this effect of ferro-manganese. A ladle full of the regular wheel mixture was used to fill smaller ladles containing different proportions of the ferro-manganese, of approximately the following analysis:

Analysis of Ferro-Manganese.

Manganese.....	80.02 per cent.
Carbon (combined).....	6.24 "
Iron.....	13.32 "
Silicon.....	0.10 "

The resultant bars were then analyzed, with the following results:

Test of Wheel Iron with Ferro-Manganese.

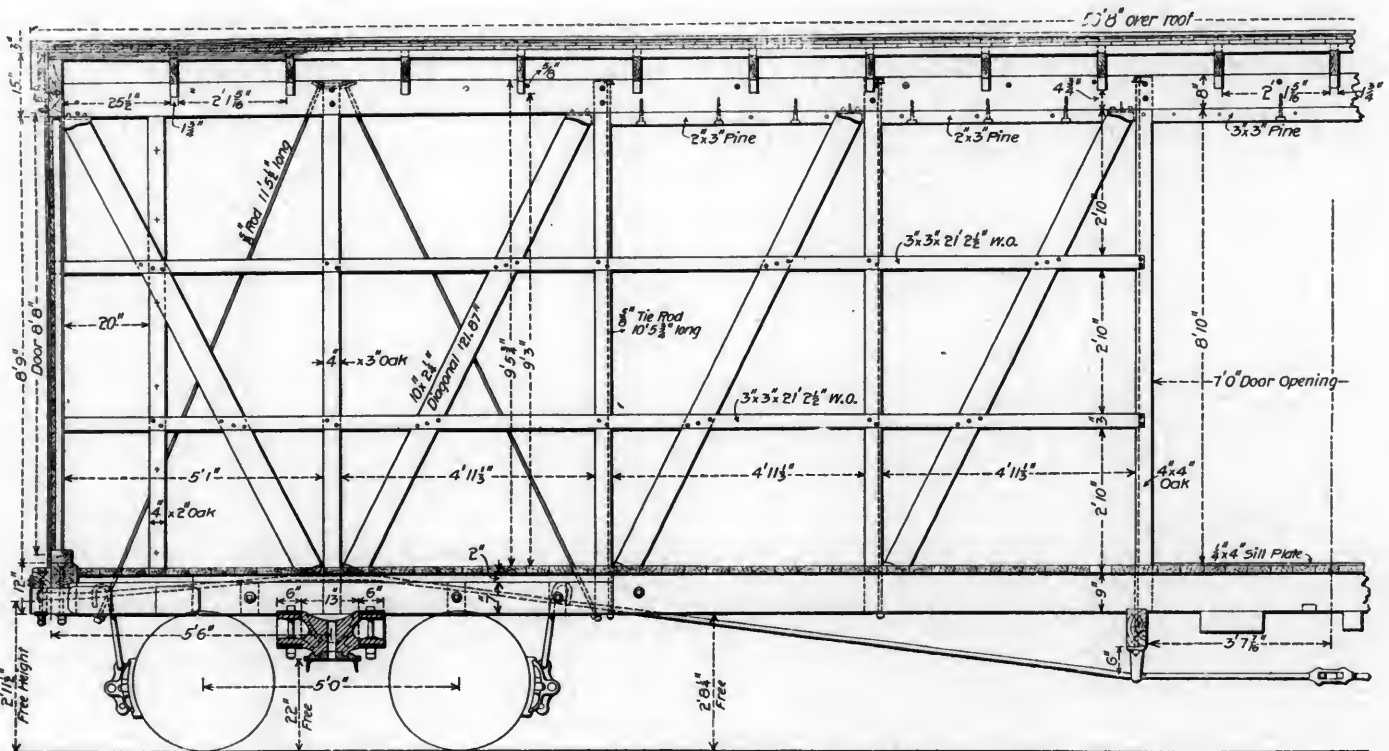
Ref. No.	Ferro-Man. added.	Fracture.	Chill.	Mn.	C. C.	G. C.
1	0.0	Light grey.	$\frac{3}{4}$ in.	0.16 p. c.	1.13 p. c.	2.30 p. c.
2	0.2	Close light grey.	$\frac{5}{8}$ "	0.19 "	0.9 "	2.55 "
3	0.3	Close darker grey.	$\frac{1}{2}$ "	0.24 "	0.80 "	2.75 "
4	0.4	Close dark grey.	$\frac{7}{8}$ "	0.32 "	0.61 "	2.82 "
5	0.5	Open dark grey.	$\frac{3}{8}$ "	0.36 "	0.66 "	2.74 "
6	0.6	Open dark grey.	$\frac{1}{8}$ "	0.45 "	0.50 "	2.84 "

These tests run remarkably even (except No. 5, which is somewhat abnormal), and by their aid a more definite knowledge of the proper irons to charge into the cupola can be obtained.

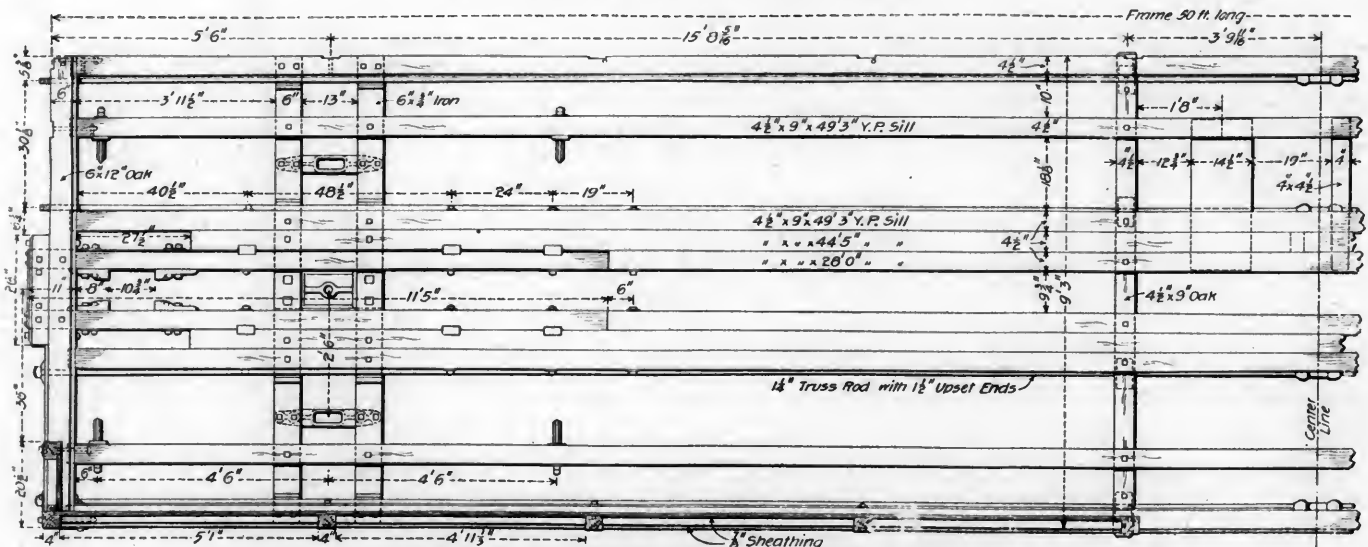
FIFTY-FOOT CARRIAGE CAR—C., M. & ST. P. RY.

Cars that may be used with equal facility for furniture or carriages have been designed and are now being built at the rate of ten per day at the West Milwaukee Shops of the Chicago, Milwaukee & St. Paul Railway. These cars, which are very large, are similar in some respects to the 46-ft. furniture cars, by the same road, which we illustrated in September, 1896, page 209, except that the carriage cars are larger and they have large end doors.

The arrangement of the under frame is unusual and worthy of note. The sills are all $4\frac{1}{2}$ by 9 in. in section and are all in the same plane. There are the usual side and intermediate sills, and at each side of the center of the car three sills are placed face to face, making a solid mass of timber, consisting of six sills to receive the buffing and pulling stresses. The draft gear is attached to long $4\frac{1}{2}$ by 7-in. draft timbers, which form a part of the two inside sills, as shown in the plan of the



Section Showing Side and Roof Framing.



Half Plan of Underframe, Showing Triple Center Sills.

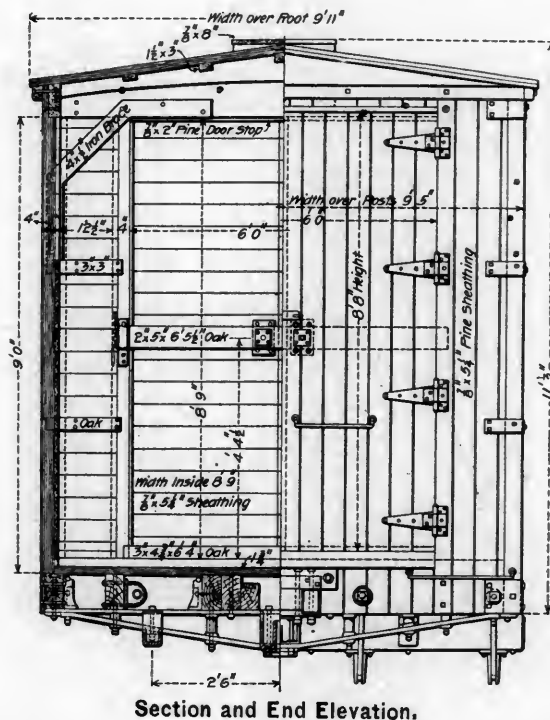
FIFTY-FOOT CARRIAGE CAR—C., M. & ST. P. RY.

floor system. The end sills are 6 by 12 in. and white oak. They are cut out at the center, not only for the coupler-shank, but also for the ends of the draft timbers. All of the bolts for the draft timbers are accessible from the outside of the car.

The body bolsters are double, of $\frac{3}{4}$ by 6-in. iron for the upper plate, and 1 by 6-in. for the lower plate. The center plate bearing is on a casting that spans the two trusses. The needle beams are $4\frac{1}{2}$ by 9 in., of red oak, and there are four body truss rods.

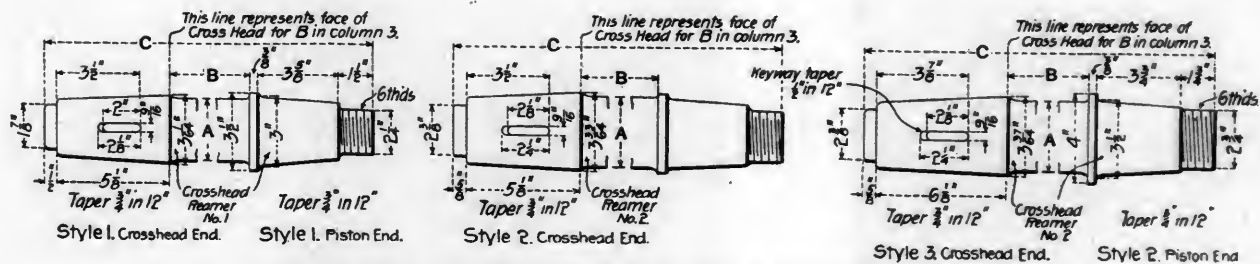
The side and end posts are not mortised into the sills and plates but are gained lightly into these timbers and secured by horizontal bolts. The rotting of tenons and mortises is avoided and repairs are made easier by this construction. There are two white oak belt rails.

The end door is shown in the end view of the car. It is



Section and End Elevation.

In two parts, each hung on four heavy hinges, and the fastening is made by a 2 by 5 in. oak bar fitting into sockets on the end posts. The clear end door opening is 6 ft. by 8 ft. 9 in., and to compensate for the large opening at the ends, the upper corners are braced by $\frac{1}{2}$ by 4 in. iron plates, welded twice, to give the desired form, and these secure the end plate to the corner posts. The side door openings are 7 ft. wide.



Forms of Piston Rod Ends Used on the Chicago & Northwestern Railway.

This car is 50 ft. 2 in. long over all, and 49 ft. 6 in. long inside. It is 9 ft. 5 in. wide outside, and 8 ft. 9 in. inside, the inside height being 9 ft. 5¼ in. The height from the rail to the top of the brake-staff is 13 ft. 11¼ in. The car body is high, and yet the total height is kept within bounds by the low trucks.

The trucks are of the Barber type, patented by Mr. J. C.

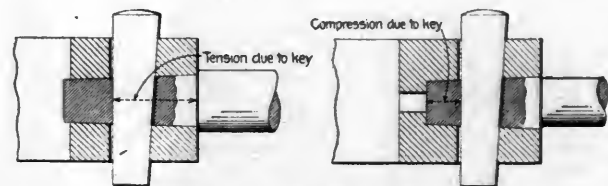
Barber, formerly Master Car Builder of the Northern Pacific, They are substantially the same design as illustrated on page 210 of our issue of September, 1896, and the drawing presented at that time gives the dimensions for the present design. They have diamond frames, and the springs are seated on plates above the bottom arch bars and between the column guides. Caps are placed upon the tops of the springs, and rollers are put between these caps and the ends of the bolsters.

The surfaces which bear against the rollers are concave, causing a tendency to bring the bolster to its central position, and the side movements of the bolster are limited to 2½ in. by brackets secured to the top members where they stop excessive movements by striking the arch bars. The bolster has a nearly straight channel for its upper member and a ½ by 10-in. steel plate for the lower member; they are riveted together at their ends. The height of the truck from the rail top to the top of the upper arch bar at the center is 2 ft. ¾ in.

The weight of the car body alone is 26,900 lbs., and with the trucks it is 37,900. We are indebted to Mr. J. N. Barr, Superintendent of Motive Power of the road, for the drawings.

PISTON ROD ENDS.

In his article on piston rods in our issue of November, 1898, page 366, Mr. F. J. Cole presented diagrams illustrating some of the faulty methods of constructing piston rods, and the use of the form in which the end of the rod is turned down with a shoulder to bear against the cross-head is in such common use that it seems desirable that the improved practice should be brought to notice again. Piston rod failures are not un-

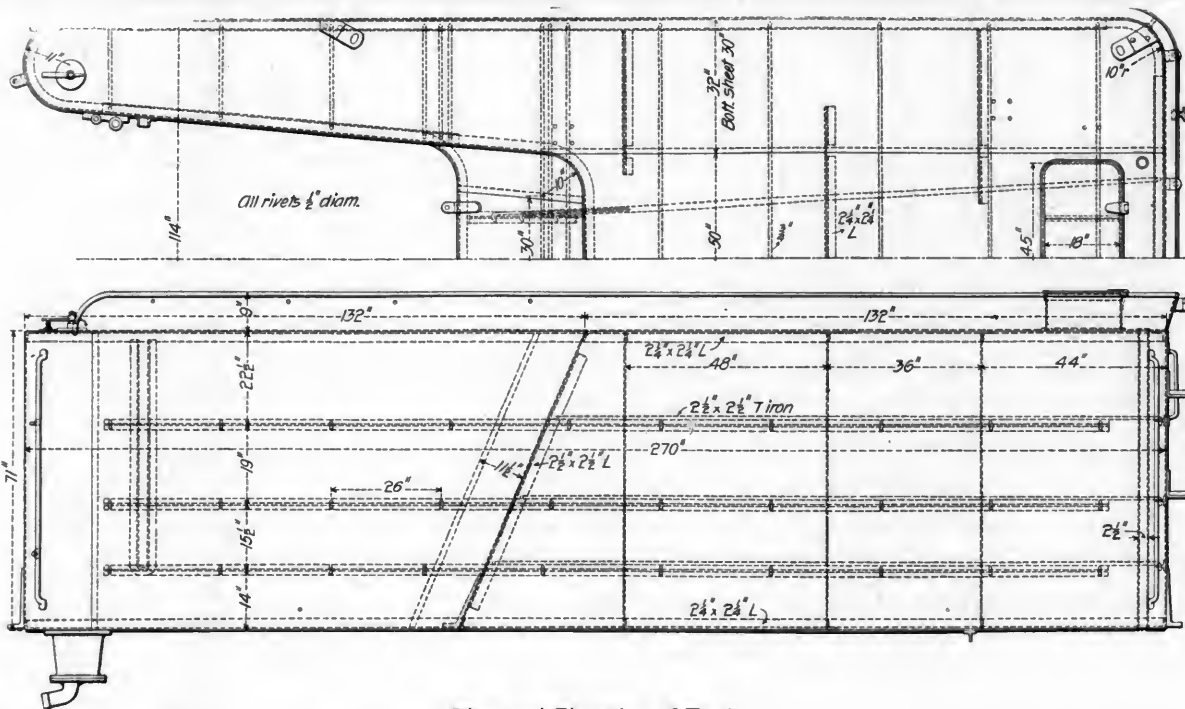


Stresses Caused by Piston Rod Keys.

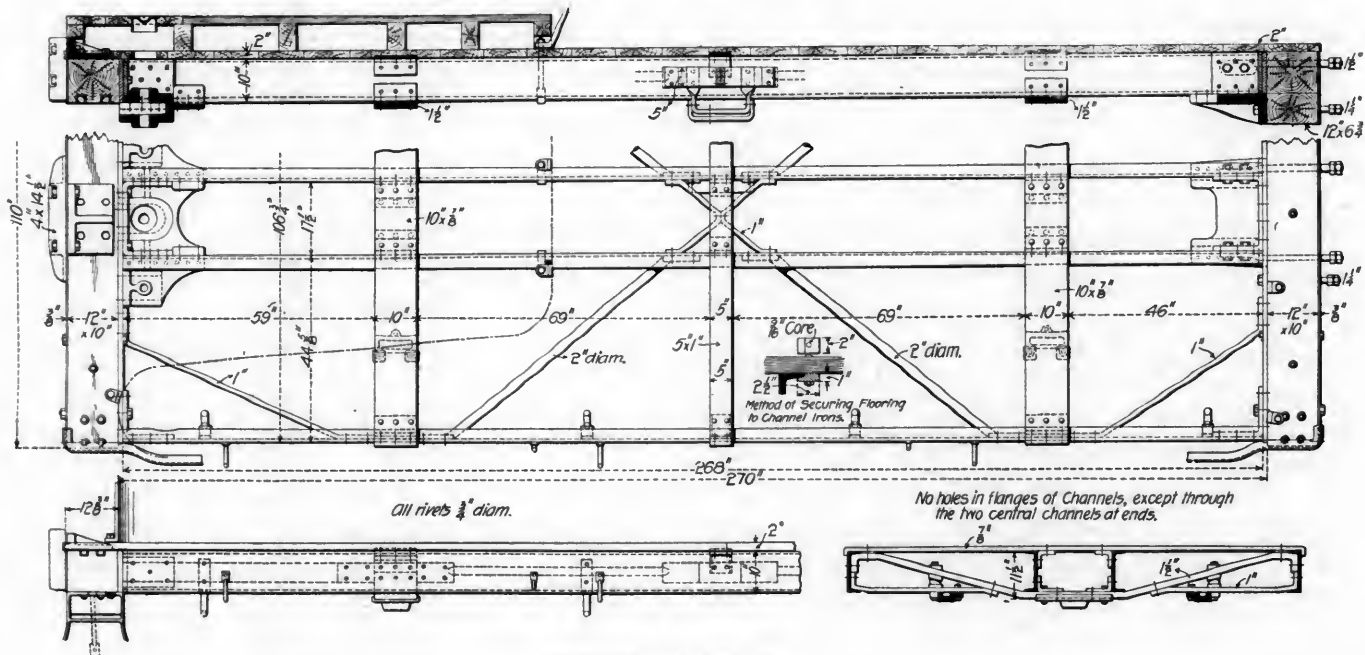
common, and the possible serious consequences of breakage emphasizes the importance of good design in this detail.

The engraving shows three piston rods which have been in use on the Chicago & Northwestern Railway for several years. These show the fits at both ends of the rods, but it is to the cross-head ends that special attention is drawn. These rods have only two sizes of enlarged ends and, while the length of the cross-head fit varies, two reamers are employed on all of the engines on the road. The sketches indicate the effect

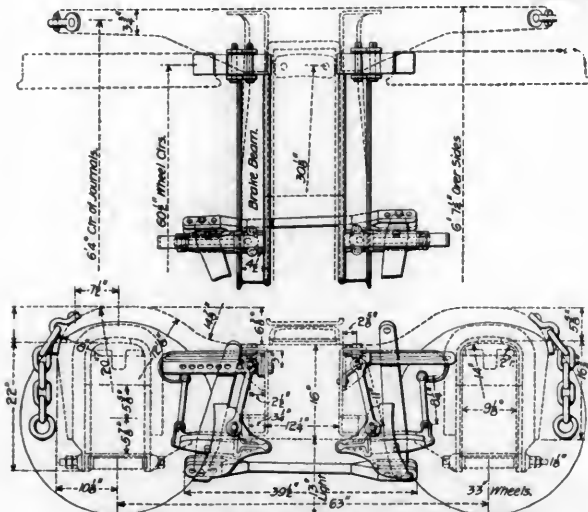
of the key upon the initial stresses in the cross-head fit, and it is clear that the enlarged ends by bottoming in the fit have the advantage of causing compression of the material at the end of the rod, as contrasted with the other form with the shoulder, in which the metal is stretched by the key in its weakest spot. This tension invites fracture, and a bad feature of the stress is that it cannot be measured or even estimated.



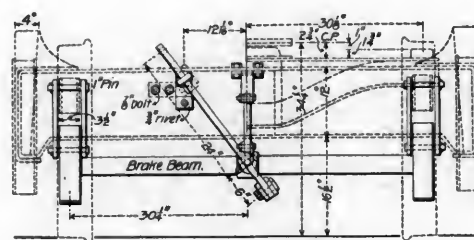
Plan and Elevation of Tank.



Underframe of Tender.

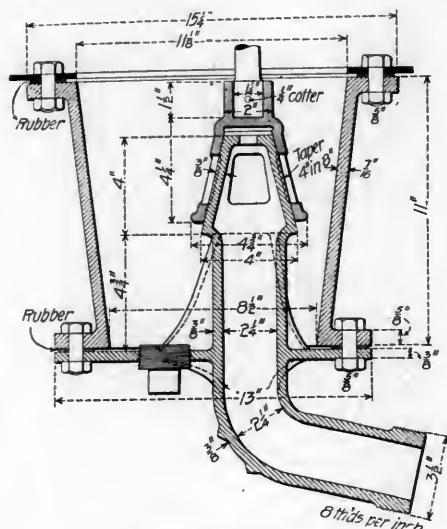


Fox Pressed Steel Truck.

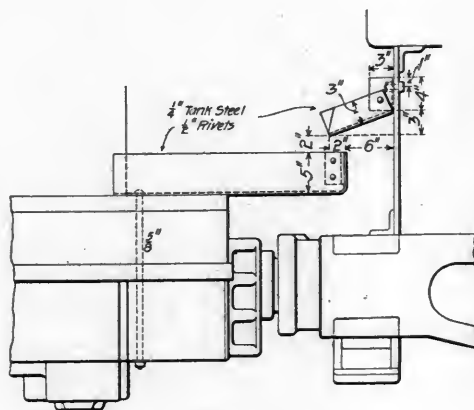


End View of Truck.

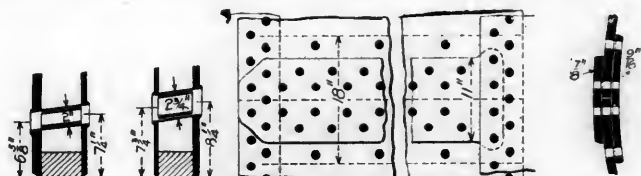
TENDER FOR HEAVY PUSHING LOCOMOTIVE.—LEHIGH VALLEY RAILROAD.
Capacity of Tank, 7,000 Gal'ons.



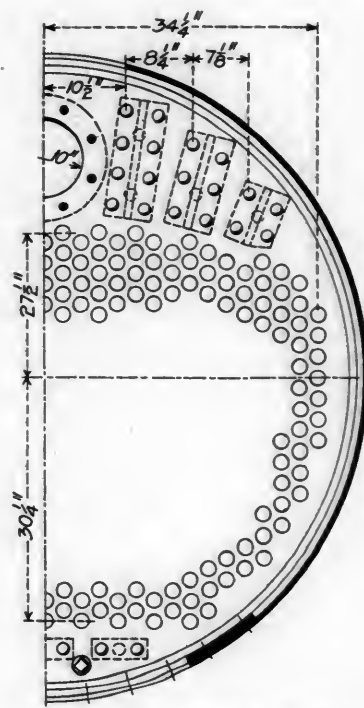
Section of Tank Valve.



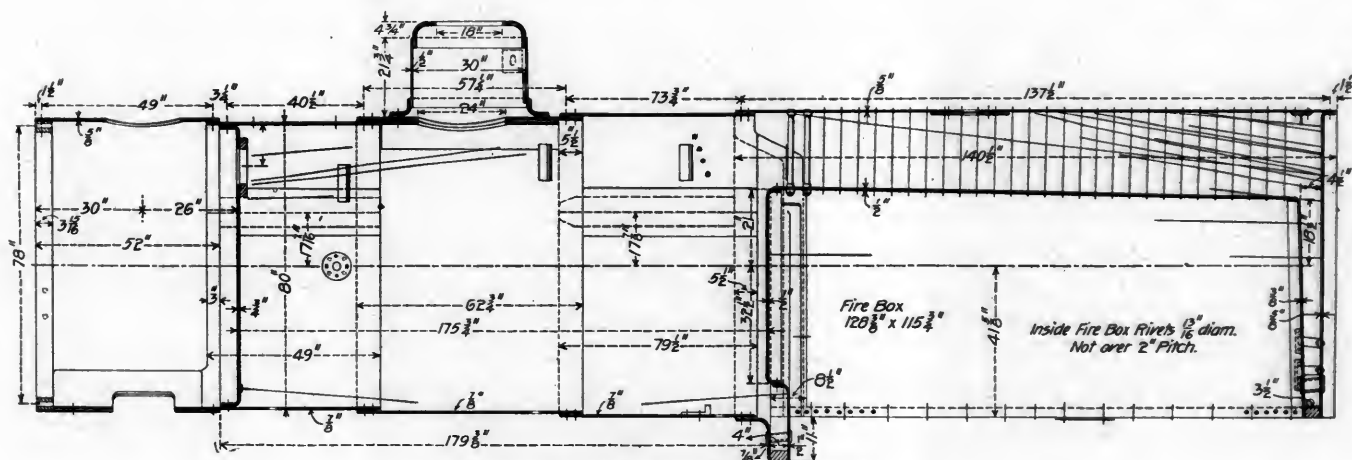
Coal Apron.



Boiler Seam and Water Space Tubes.

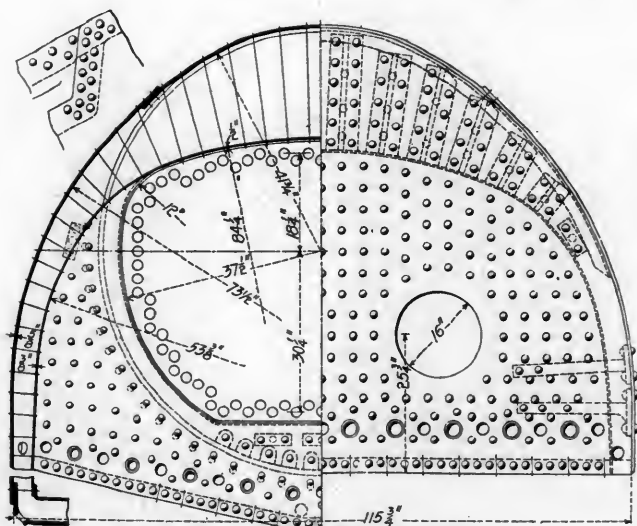


Section Through Boiler.



Longitudinal Section Through Boiler.

BOILER AND TENDER FOR HEAVY PUSHING LOCOMOTIVE, LEHIGH VALLEY RAILROAD.



Section and Elevation of Firebox.

The remarkable capacity of the mountain pusher locomotive built by the Baldwin Locomotive Works for the Lehigh Valley, illustrated in the "American Engineer" of December, 1898, page 395, is shown by the engravings of the boiler and tender. These are larger than any of which we have record. The boiler carries 200 pounds pressure and its heating surface is 4,105.6 square feet, the grate area being 90 square feet. The fact that the engine is a compound was commented upon last month, and while it is too early to predict as to the performance of the engine, we feel warranted in commending the boldness of the designers with reference to the immense heating surface and the compounding. In this case it is important from an operating point of view, as well as in economical operation, to provide large enough water carrying capacity to avoid stopping to fill the tank, and the features just mentioned ought to be very helpful in securing the desired result. The design exhibits unusual care in its plan and execution,

and it may have a marked influence on the heavy locomotive of the future.

Through the courtesy of Mr. S. Higgins, Superintendent of Motive Power of the road, we have drawings of the boiler and tender. The former requires little explanation, but attention is called to the large number of tubes, 511, and their length, 14 ft. 7 $\frac{3}{4}$ in. The firebox is of the Wootten type, for anthracite coal, and is 120 by 115 inches in size, the form being in compound curves struck from different centers. In this type of wide firebox boiler it is customary to make the sides flat with an arched crown, but in this design, which is like the Lehigh Valley standard, much enlarged, the firebox is made as nearly as possible a part of a true circle. This is done to increase the life of the staybolts on account of avoiding sudden changes of curvature and also, for the same width of firebox, the maximum firebox heating surface is obtained. The water spaces begin with a width of 3 $\frac{1}{2}$ inches at the mud ring, except in front, where it is 4 inches, and they increase immediately above the mud ring. The disposition of the tubes is clearly shown. There are two firing doors 16 inches in diameter. We give details of the longitudinal seams. These seams are sextuple riveted and they have an efficiency of about 82 per cent. The smoke arch is a $\frac{5}{8}$ -inch plate, the body courses are $\frac{7}{8}$ inch, the outside firebox sheets are $\frac{5}{8}$ inch and the inside firebox sheets are $\frac{1}{2}$ inch thick. The firebox sheets have two seams each. The mud plug holes at the corners are pressed outwardly to give good bearings for the plugs, this being a feature of the Baldwin boilers. The dome is on the second course, and has a pressed steel connection. There are 480 1 $\frac{1}{2}$ inch and 1,255 one inch screw stays in this boiler. The diameter outside the first course is 80 inches.

The use of the auxiliary dome permits of attaching three safety valves without cutting the cup of the main dome. The short combustion chamber is found beneficial in prolonging the life of the flues, because it protects them somewhat from the air that may get through holes in the fire, and being short it is not necessary to stay the sides. Furthermore this shape of front firebox sheet is more flexible than the usual form and is less troublesome from cracking, and yet a new tube sheet may be easily put in when necessary without disturbing the rest of the firebox.

The heating surfaces insure good steaming and we are informed that with fine buckwheat coal the engine steams very freely.

The tender carries 7,000 gallons of water and, when empty, weighs 45,250 pounds, the weight of the water alone being nearly 60,000 pounds. This is carried on two Fox pressed steel trucks with coil springs, 8 inches in diameter by 6 inches high over the journals, and 26 inch elliptic springs under the bolsters. The latter are double with 16 4 by 5-16 inch plates, and are designed to carry 7,500 pounds at a height of 9 inches over the bands. The wheels are chilled cast iron, 33 inches in diameter.

This engine has been in use about two months, and has given entire satisfaction. The object of the large capacity and some of the special features of the design are given in a letter from Mr. F. F. Gaines, Mechanical Engineer of the road, which we give in his own words. They present a strong argument for large tenders. Mr. Gaines says:

"I am aware of the fact that the use of large tenders has become a very important issue upon many roads, because the increased coal and water capacity often enable a train to save several hours delay by getting to a point where they will be out of the way of other trains; also in fast passenger service between competitive points, a question of a few minutes saved in running time is often of vital importance, and there is no question but that increased tank capacity will often save several minutes which would otherwise have been lost in taking coal or water.

"This tender was designed for use behind pushing engines on the grade between Coxton and Fairview (27 miles). The

trains on this grade are frequently handled by one leading and two pushing engines, so the question of stopping to take water is of great importance. The new tender was designed after we had found from actual service what quantity of water would be required by a pushing engine to make the trip without stopping for water.

"In designing the tender several points were considered. All patterns and wearing parts were made interchangeable with the present standard tender. In designing the truck it was necessary to depart from the standard to provide for the greater journal load. In doing this we adopted the M. C. B. 5 x 9 inch axle, journal bearing, and wedge, as the possibility of their use in the near future under freight cars of large capacity is extremely probable.

"There are some points about the tender which, though standard on this road, may be of interest to others. The feed pipe valve drains the tank entirely, and in cases where every inch of water in the tank is needed, this construction is desirable. The inlet of the valve is so located that a residue is left for the accumulation of any dirt or ashes that may get into the tank. This accumulation can be removed whenever the engine is washed out by taking out the washout plug in the bottom of the valve chamber.

"The manhole is unusually large to allow free access of the water crane, without making it necessary to stop exactly in line with it. This design of manhole was adopted several months previous to the publication of an article on the subject in the "Railroad Gazette" of August 19th, 1898.

"The use of steel plates on the outside of the front and rear end sills saves many broken draft castings, and will prolong the life of the sills themselves. There are no holes in the flanges of the channels, except at the extreme ends, thus preserving their entire available strength.

"With fine coal, such as will be used on pushing engines, the tender apron saves its cost in a short time, by preventing the coal from working off the tender, when the tender has a full load."

TOPEKA SHOPS, ATCHISON, TOPEKA & SANTA FE RAILWAY.

Editorial Correspondence.

The chief buildings of the locomotive and car repair shops of the Atchison, Topeka & Santa Fe, at Topeka, are neither impressive nor modern, but the plant is an exceedingly busy one, and it is an excellent example of the good use of existing facilities. A generous policy is followed with regard to labor-saving conveniences. These appear very generally all over the works, and one who has not visited them for a couple of years will find much to be studied. When dies, formers and jigs are found distributed about a plant of this kind it is evident that many minds are active in co-operative efforts to reduce the cost of work and replace the labor of men by the use of machinery. This is exemplified by a very modest, but exceedingly business-like, corner of one of the machine shops, which is devoted to the production of labor-saving appliances. Four lathes and several benches are kept busy here in this way.

Several machine tools recently added to the plant are especially worth noting. The first is a double spindle Newton lathe, which will swing work 26 and 44 inches in diameter by 7 feet in length. This is a convenient machine because of the wide range of work it will take, and it is powerful enough for heavy pieces on the upper centers, and yet is very handy for lighter work. It is a good tool for terminal points, where it is desirable to combine in a small shop a variety of capacities in a single lathe. Another good machine is a Richards' open side planer, by Pedrick & Ayer, having a bed 24 feet long. A rotary shear in the boiler shop is found convenient in cutting circular holes. It will cut plate $\frac{5}{8}$ inch thick. A new set of bending rolls, driven by an air engine, has been placed in

a new building near the large blacksmith shop. This machine will bend sheets 12 feet wide and $1\frac{1}{4}$ inches thick. It was furnished by Wickes Brothers, Saginaw, Mich. A large No. 5 double bulldozer by Williams, White & Co. has been placed under the same roof with the bending rolls. The work for this machine is heated in a large oil furnace near by, and we found 150 truck arch bars of $1\frac{1}{4}$ by 4-inch iron being bent to shape in eight hours at the time of the visit. The waste heat from this furnace on its way to the chimney flue passes through an oven or box in which all of the case hardening work of the plant is done. Experiments are now being tried in the use of "scintilla," a case hardening compound, furnished by Messrs. Paul, Martin & Co., of No. 101 Aldersgate St., London, England. The claims made for it are uniformity and rapidity of case hardening, and an experiment shows that a depth of 1-32 inch of hardening has been obtained in about five hours, while a depth of 3-32 inch has been secured in about 12 hours. By ordinary methods, it had not been customary to get over 1-16 inch in from 12 to 14 hours. If further results are equally satisfactory it will be possible to do the case hardening during the regular working hours of the shop instead of always requiring night work, which is the present practice. We are informed that this material has been used successfully on driving axles of the Great Western Railway of England, where a depth of 1-16 inch is regularly obtained in 12 hours.

A new arrangement of oil furnace has been devised here, in which the flame is carried entirely across the furnace and upon its return it comes against the iron to be heated, the spray being obtained by a blower blast. In one of the forge shop furnaces the stock for forging car center pins is heated at the rate of 100 pins per hour, the furnace taking nine at a time. These are made in a forging machine, located at the furnace, at the rate of a thousand per day. Oil furnaces are in general use about the shops, and also in the outlying building, where the brake work for cars and the bolt work is done. It has been found advantageous to provide an oil supply at each furnace in order to keep somewhat of a check upon the consumption. This is done by means of an elevated tank near each group of furnaces, and these are filled from the large supply tanks by aid of air pressure and a system of underground piping.

The substitution of crushed steel abrasive for emery for the grinding in of valves and steam tight joints was found satisfactory. Two sizes of the abrasive known as Nos. 170 and 120 are used, the former for brass and the latter for cast-iron. This abrasive does not crush or pulverize, and besides cutting quicker than emery, there is less waste. With a small rotary air motor running at 170 revolutions per minute, a steam joint is ground in 20 minutes. This material has replaced all but flour emery; it is so economical that an amount that may be held on a five-cent piece is sufficient for grinding a steam pipe joint. The material is known as diamond crushed steel abrasive, and is furnished by the Pittsburg Crushed Steel Co., of Pittsburg, Pa.

The new car repair shop, which is about 200 by 800 feet in size, is an excellent investment, and the work that was formerly done out of doors is now done under this roof for protection of the men against the weather. The repair work goes on steadily the year round, and it is believed that the building more than pays for itself in a year. One track in this building is devoted to new work. About 500 cars were built last year, and about that number will be built this year. It is the policy of this company to build a new car to replace every one destroyed. This large building is well supplied with connections for air piping, for various portable tools and for the air jacks with which the cars are raised and lowered. Air connections are provided at every alternate line of posts. Two men raise and lower all cars, as well as remove and replace their trucks. Two other men handle the pneumatic tools for boring holes. The circular saws driven by compressed air in this shop are very convenient; there are several small portable saw tables driven by 5-inch single cylinder air motors, and an emery

wheel for sharpening chisels and similar tools is driven in the same way. A very ingenious device is a circular saw combined with a motor, mounted in a frame, for the purpose of cutting off the ends of the roof boards in place. This is pushed along the edge of the roof like a lawn mower, and it cuts very rapidly. The shop is provided with cross tracks, and instead of turn-tables a large number of air jacks are provided, the plungers of which come up under the small push cars loaded with material, and by taking a bearing on a casting under the center of the car it may be raised so that the wheels will clear the track, whereupon the jack becomes a turn-table.

A great deal of attention is now being paid to standardizing the storehouse stock, with a view of reducing the amount of material carried. A complete catalogue of all the material used about locomotives and cars is being made, and the idea is to reduce the number of sizes to the minimum. This applies to all kinds of stock, and by distributing copies of the catalogue the ordering of odd and unusual sizes is to be prevented. This is a large undertaking and is being carried out by Mr. Hancock, with the assistance of an apprentice. In the storehouse the variety of malleable iron fittings for locomotives at once attracted attention. A large number of parts usually made in brass or wrought iron are found to be equally satisfactory in malleable iron, and the smoothness and accuracy of the castings is remarkable. Among these are handles for globe and other valves, with the spindle holes cored so nicely as to avoid all necessity for machine finishing. Oil cups, reverse lever latches, brake wheels and other parts are very successfully cast in malleable iron. The castings seen were made by the Dayton Malleable Iron Co., and when such malleables are available there is no reason for continuing the use of brass.

The use of pneumatic tools in these shops is extending, and the present capacity of the compressing plant, which is 1,200 cubic feet of free air per minute, is barely sufficient for the requirements. The large Rand compressor furnishes 1,700 cubic feet, and a 14 by 42-inch cylinder, which was connected in tandem arrangement to the machine shop engine in 1891, furnishes about 400 cubic feet per minute. The air piping system extends more than a mile from the compressors. At a distance of a half mile away rails are cut and drilled by pneumatic power. In the shops a number of 300-pound steam hammers are operated by air. It is said that they are quicker in movement and there is no trouble from condensation. In the boiler shop we found the last two of 12 new boilers built this year, and the riveting has practically all been done by air. Locomotive tanks, holding 5,000 gallons, are machine riveted throughout, except the upper connection at the back of the coal space. By the use of compressed air in the sand tower, sand is elevated and delivered to locomotives by the "hostlers," saving about \$3.75 per day. In one of the shops we found a frame for heading $\frac{3}{4}$ -inch rivets by means of pneumatic hammers. The frame has a gap of 10 feet, and is made of two 5-16-inch plates, braced with angle irons. Sand blast apparatus is used in cleaning paint from tanks, and a 4,000 gallon tank is cleaned all over in four hours. The sand blast outfit is mounted on a two-wheeled hand wagon. The receptacle for sand is a large auxiliary reservoir, which is filled with sand twice for a tank. The weight of the apparatus empty is 443 pounds, and the weight of the sand is 330 pounds. Air at from 80 to 90 pounds pressure is used.

While it is probably true that some of the operations effected by pneumatic power at these shops might be more economically performed in most places by some other power, it is also true that the convenience and ease of distribution of compressed air are advantageous, and while small air motors may not be theoretically efficient, their extensive use is justified by the cheapness in cost of production of the power, coal only being used under the boilers at night and the major portion of the supply being obtained from burning refuse lumber from the car department.

We are indebted to the courtesy of Mr. John Player, Superintendent of Machinery, and Mr. George A. Hancock, Assistant Superintendent of Machinery, for an instructive and enjoyable visit to these shops.

COMMUNICATIONS.

SHORT SMOKE BOXES FOR LOCOMOTIVES.

Editor "American Engineer":

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You refer particularly to Mr. J. Snowden Bell as deserving of credit for persistent presentation of his design and its successful use in a number of instances. My agreement with this view of the matter is the occasion of this letter, as I happened to be well informed as to his efforts in the past and aware of the success reached by his design of smoke box and front-end appliances used therein. He has pressed this plan for consideration from a time when the current set strongly in favor of long smoke boxes and their internal fixtures. The writer was not carried away with the first extension smoke box by J. H. Congdon (the original Jacob of this design), Superintendent of Machinery of the Great Western Railway—not enough, in fact, to try it—but he did profit by the hint given, and extended the smoke box in some engines then being built by several inches—I believe, four inches—from the very short boxes then used. Mr. Congdon did not obtain entirely satisfactory results with his design, and abandoned its use when leaving the Great Western to become Superintendent of Motive Power of the Union Pacific, and the long front, with here and there a spasmodic attempt by others, for quite a time made no great headway. Smoke boxes generally, however, were made somewhat larger as a result of his experiment.

Later on the extension front, as it was called, again made appearance in connection with the straight open stacks, and in some instances also with improved internal appliances of smoke box, coupled with improved furnace arches resting upon water tube supports, and with arch brick perforated with holes for the consumption of gases. The success due largely to these helped the introduction of long smoke boxes and open stacks generally.

In his contention for short boxes Mr. Bell has not antagonized any of these where they are in use, but persisted in the shortening up of the long boxes and the use therein of his design or arrangement of nettings, plates, lifting pipes, height of exhaust nozzle, etc., for success.

The plan shown in Fig 4, on page 393 of your December, 1898, issue, of the Baltimore & Ohio design, has met very nearly my idea of what this arrangement ought to be. I notice, however, in the experience had with Fig. 6 plan, Wisconsin Central Railway, there is complete success in free steaming, and, even when observed at night from the locomotive, a freedom from spark emission of dangerous nature.

When coal is fed to the furnace in proper quantity at a time, and of a proper size, good results will usually follow the use of ordinary devices in the prevention of smoke and spark emission. I was at one time so impressed with this—when in charge of locomotives of a Western railroad—that I appointed one of the best firemen as foreman fireman and instructed him in his duties, and the engineers and firemen were to observe his instruction to them. In addition, Sinclair's book on "Combustion of Coal" was supplied to them, and, altogether, it was found to be a satisfactory experiment. Ordinarily, however, the calmness or indifference of fuel users must be guarded against, and it is my opinion, based upon experience, and wide observation that the Bell design of short smoke box, taken complete in its details, will come as near doing this as is desired, with the straight open stack.

You have drawn upon the experience of Mr. J. H. McConnell, Superintendent of Motive Power of the Union Pacific Railway, as related to the 1898 Convention of Master Mechanics' Association, to illustrate your position as stated, and there is no doubt of correctness in this instance. It would, however, be interesting if Mr. McConnell should make a good service test of the Bell design of smoke box in connection with the diamond stack which he is now using on engines, with the view of eliminating all sparks in the use of the Wyoming lignite coal.

GEO. W. CUSHING.

308 Western Union Bldg., Chicago, Ill., Dec. 12, 1898.

BROOKS CONSOLIDATION LOCOMOTIVE.

Oregon Railroad & Navigation Company.

In November of last year the Brooks Locomotive Works built three consolidation locomotives for the Oregon Railroad & Navigation Company.

These engines weigh 136,200 lbs. on drivers and the weight of the engine in working order is 154,000 lbs., the total of engine and tender being 252,000 lbs. They have 19 and 30 inch cylinders, 10 inch piston valves and the Player patent Belpaire boiler, with supplemental steam dome. The boiler is 64 inches in diameter and has a total heating surface of 2,162 square feet with a firebox 114 by 42 inches, giving 32.4 square feet of grate area. The firebox is above the frames.

There are several features in the design of the details that are unusual and some are new. The frames are narrowed down at the cylinders, where they take the form of slabs. The spring rigging is "over-hung," with the equalizers between the upper and lower bars of the frames, and links are used between the ends of the springs and the equalizers. The first pair of driving wheels are equalized across the engine by a spring with 6 by $\frac{1}{2}$ inch leaves, and by this spring they are equalized with the pony truck. The crosshead is "H" form, and very light for an engine of this weight. The piston rods, also the valve stems, are extended. The driving wheels have cast steel centers and all of the tires are flanged. The link lifters are combined in a single arm of cast steel placed at the center of the width of the engine, and each link has a suspension bar from the lifter arm. This arm projects through the guide yoke and is seen in the photograph. The reach rod is also a departure from common practice, being a 2 inch extra strong pipe with ends welded in. The cab is of sheet metal and its floor is flush with the deck and the running boards. Among the details of the running gear we notice that the main crank pins are enlarged in the wheel fits. They have a diameter of 7 inches at the inside rod bearing and $7\frac{3}{8}$ inches in the wheel. This is commendable, and it might be well applied to all the pins. With the exception of the main pins the crank pins are hollow. The following table gives the chief dimensions of the engine:

Gauge	4 ft. 8 $\frac{1}{2}$ in.
Kind of fuel to be used.....	Bituminous coal
Weight on drivers	136,200 lbs.
" truck	17,800 "
" total, engine.....	154,000 "
" of tender, loaded.....	98,000 "
" engine and tender, loaded.....	252,000 "

General Dimensions.

Wheel base, total, of engine.....	23 ft. 2 in.
" driving	14 ft. 6 in.
" total, engine and tender.....	51 ft. 8 $\frac{3}{4}$ in.
Length over all, engine.....	38 ft. 1 $\frac{1}{2}$ in.
" total, engine and tender.....	60 ft. 11 $\frac{1}{2}$ in.
Height, center of boiler above rails.....	8 ft. 11 in.
" of stack above rails.....	14 ft. 10 $\frac{1}{2}$ in.
Heating surface, firebox and arch pipes.....	2,162 sq. ft.
" tubes	1,953 "
" total	2,162 "
Grate area.....	32.4 "

Wheels and Journals.

Drivers, diameter.....	55 in.
" material of centers.....	Cast steel
Truck wheels, diameter.....	30 in.
Journals, driving axle, main.....	8 $\frac{1}{2}$ by 11 in.
" front, back and intermediate.....	8 $\frac{1}{2}$ by 11 in.
" truck	5 $\frac{1}{2}$ by 10 in.
Main crank pin, size.....	6 $\frac{1}{2}$ by 6 in.

Cylinders.

Cylinders	19 by 30 in.
Piston rod, diameter.....	4 in.
Main rod, length center to center.....	125 in.
Steam ports, length.....	21 in.
" width	2 in.
Exhaust ports, least area.....	54 in.
Bridge, width.....	31 $\frac{1}{2}$ in.

Valves.

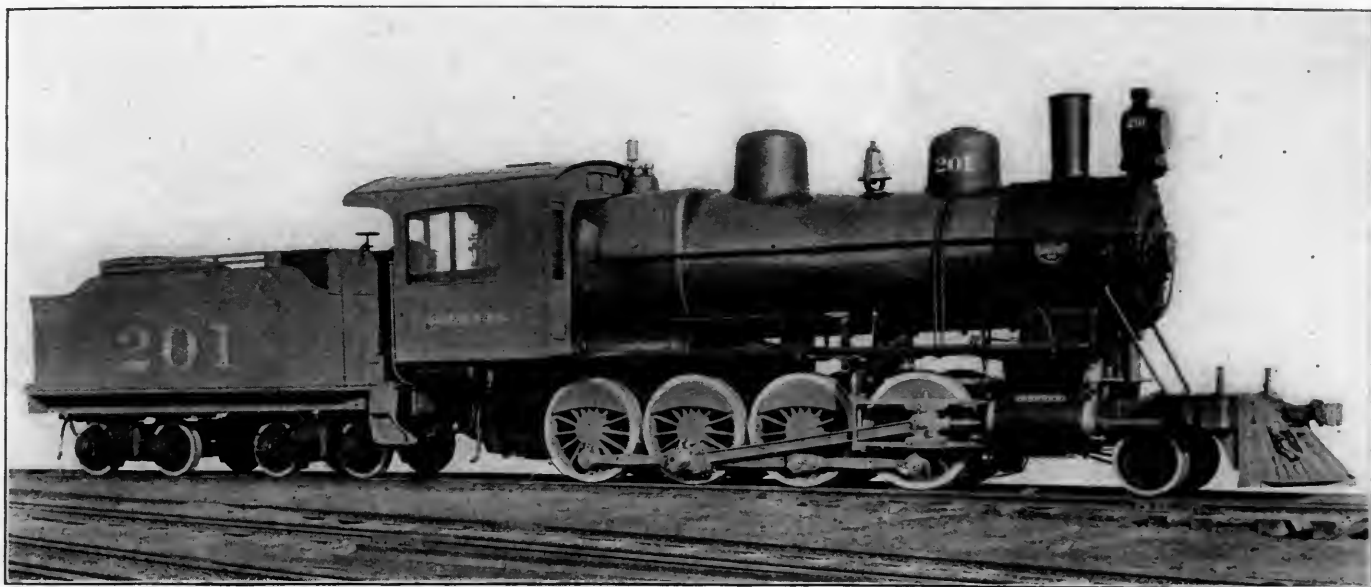
Valves, kind of.....	Piston
" greatest travel.....	7 in.
" steam lap (inside).....	1 $\frac{1}{4}$ in.
" exhaust clearance (outside).....	$\frac{1}{8}$ in.
" lead in full gear.....	1-16 in. negative

Boiler.

Boiler, type of.....	Player, Belpaire
" working steam pressure.....	200 lbs.
" thickness of material in barrel.....	$\frac{3}{8}$ in.
" tube sheet.....	$\frac{1}{4}$ in.
" diameter of barrel.....	64 in.

Crown sheet stayed with.....	Direct stays
Dome, diameter.....	30 in.
Firebox.	
Firebox, length.....	114 in.
" width.....	42 in.
" depth, front.....	75 in.
" " back.....	69 in.
" thickness of sheets.....	3/8 in. and 5/8 in.
" mud ring, width.....	Front, 4 in.; back, 3 1/2 in.; sides, 3 1/2 in.
Grates, kind of.....	Cast iron, rocking
Tubes, number of.....	286
" material.....	Charcoal iron
" outside diameter.....	2 in.
" length over tube sheets.....	13 ft. 2 1/4 in.
Smoke Box.	
Smoke box, diameter outside.....	67 in.
" length from flue sheet.....	60 in.

the shops, the intention being to begin at the mill where steel plates come out of the rolls and put out the finished cars at the other end. All the shop machinery will be run by electricity, and it is needless to say that every known device to economize at every point will be adopted. Rolled shapes will be used, as these have proved stiffer than the pressed shapes employed in steel cars. It is stated that the Carnegie Steel Company, Limited, can roll shapes on the mills as redesigned as cheap as the straight plates. The capacity of the plant will be 40 cars per day. The enterprise is in no wise antagonistic to the Schoen Pressed Steel Company; on the contrary, the two concerns will work in harmony. It is believed that no one concern can possibly meet the coming demand for steel cars and it is regarded as doubtful whether the two plants can do so. We understand that it is the policy to concentrate the steel car business in Pittsburgh, if possible."



Brooks Consolidation Locomotive—Oregon Railroad & Navigation Company.

Other Parts.

Exhaust nozzle, single or double.....	Single
" " variable or permanent.....	Permanent
" diameter.....	5 in., 5 3/8 in., 5 1/2 in.
" distance of tip above center of boiler.....	1 in.
Netting, wire or plate.....	Wire
" size of mesh or perforation.....	2 1/4 x 1 1/4 and 2 1/2 x 2 1/2
Stack.....	Steel taper
" least diameter.....	15 1/8 in.
" greatest ".....	18 1/4 in.
" height above smoke box.....	38 in.

Tender.

Type.....	Eight-wheel
Tank capacity for water.....	4,500 gals.
" coal.....	10 tons
Type of under frame.....	Steel channel
" springs.....	Double elliptical
Diameter of wheels.....	33 in.
" and length of journals.....	4 1/4 in. x 8 in.
Distance between centers of journals.....	6 ft. 3 in.
Diameter of wheel fit on axle.....	5 1/2 in.
" center of axle.....	4 1/4 in.
Length of tender over bumper beams.....	22 ft. 1 1/2 in.
Width " tank.....	19 ft. 6 in.
Height " " not including collar.....	9 ft. 10 in.
Type of draw gear.....	Standard M. C. B.

Special Equipment.

Sight feed lubricators.....	Nathan No. 9
Safety valves.....	Kunkle
Injectors.....	Monitor Simple No. 8 and No. 9
Springs.....	French

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"After testing the experimental cars for about two years the management have become so thoroughly satisfied of their superiority over wooden cars that it was resolved to erect very large steel car building shops, including a new plate mill, wheel foundry and axle plant, so that every part of the car can be finished by continuous progress out of the raw material produced by the Carnegie Steel Company. The property just purchased is 4,000 feet long and at least 1,500 feet will be used for

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Length over all, engine	38 ft. 1 $\frac{3}{4}$ in.
" " total, engine and tender	60 ft. 11 $\frac{3}{4}$ in.
Height, center of boiler above rails	8 ft. 11 in.
" " of stack above rails	14 ft. 10 $\frac{1}{2}$ in.
Heating surface, firebox and arch pipes	204 sq. ft.
" " tubes	1,958 "
" " total	2,162 "
Grate area	32.4 "

Wheels and Journals.

Drivers, diameter	55 in.
" " material of centers	Cast steel
Truck wheels, diameter	30 in.
Journals, driving axle, main	8 $\frac{1}{2}$ by 11 in.
" " front, back and intermediate	8 $\frac{1}{2}$ by 11 in.
" " truck	5 $\frac{1}{2}$ by 10 in.
Main crank pin, size	6 $\frac{3}{4}$ by 6 in.

Cylinders.

Cylinders	19 by 30 in.
Piston rod, diameter	4 in.
Main rod, length center to center	125 in.
Steam ports, length	21 in.
" " width	2 in.
Exhaust ports, least area	54 in.
Bridge, width	3 $\frac{1}{2}$ in.

Valves.

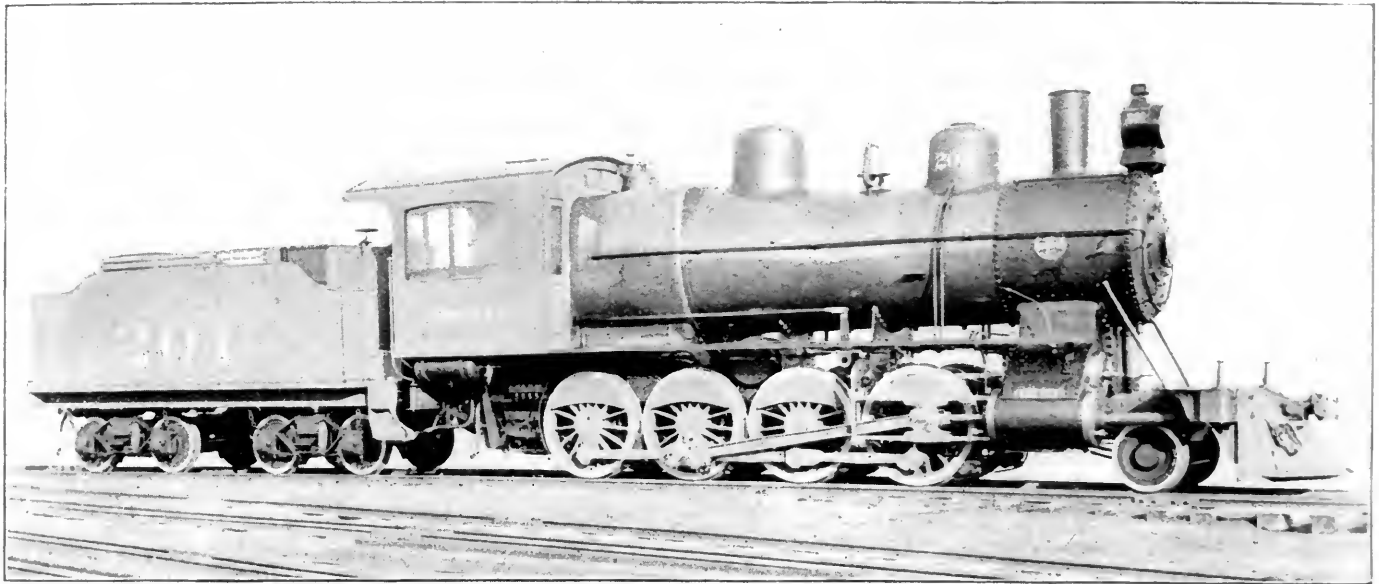
Valves, kind of	Piston
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" " steam lap (inside)	1 $\frac{1}{2}$ in.
" " exhaust clearance (outside)	1 $\frac{1}{2}$ in.
" " lead in full gear	1-16 in. negative

Boiler.

Boiler, type of	Player, Belpaire
" " working steam pressure	200 lbs.
" " thickness of material in barrel	5 $\frac{1}{2}$ in.
" " " tube sheet	3 in.
" " diameter of barrel	64 in.

Crown sheet stayed with.....	Direct stays
Dome, diameter.....	30 in.
Firebox.	
Firebox, length.....	114 in.
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" mud ring, width.....	Front, 4 in.; back, 3 1/2 in.; sides, 3 1/2 in.
Grates, kind of.....	Cast iron, rocking
" number of.....	286
" material.....	Charcoal iron
" outside diameter.....	2 in.
" length over tube sheets.....	13 ft. 2 1/4 in.
Smoke Box.	
Smoke box, diameter outside.....	67 in.
" length from blue sheet.....	60 in.

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" " variable or permanent.....	Permanent
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" distance of tip above center of boiler.....	1 in.
Netting, wire or plate.....	Wire
" size of mesh or perforation.....	2 1/2 x 1 1/4 and 2 1/2 x 2 1/2
Stack.....	Steel taper
" least diameter.....	15 1/2 in.
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Tender.	
Type.....	Eight-wheel
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BY

R. M. VAN ARSDALE,

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Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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The substantial recognition which this paper is receiving in this and foreign countries is extremely gratifying to the management and staff. A large number of prominent men have been added to our subscription lists during the past year, and many commendatory letters have been received from old subscribers, indorsing our efforts to publish a journal that meets their approval. Our purpose is to make each issue better than the previous one.

The significance of the placing of orders for 20 locomotives for the Midland Railway in the United States is not yet clear, but the promise of very early delivery probably has some influence. These will be built in lots of 10 each, by the Baldwin and the Schenectady works. The explanation offered for ordering here is that the English works are crowded.

The views of Sir W. H. White on engineering education, printed elsewhere in this issue, supported, as they are, by rare

experience and opportunities for studying the effects of education, are commended to the consideration of young men contemplating engineering work, and of those who have to do with their guidance. The necessity for preparation for education appears to merit thought, and also the importance of the place, in the order of time, given to practical experience.

In his article on the design of parallel or "side" rods in this issue, Mr. F. J. Cole gives a valuable table of moments of inertia of different sections of rods varying from 3 to 6 in. deep. These are original with Mr. Cole and were worked out specially for this article. We desire to direct special attention to Mr. Cole's tables and diagrams presented in earlier articles. They afford means for saving a great deal of labor by designers and others who are examining or improving their practice. The operating officers of the future will demand locomotives that will not break down. Failures of locomotives on the road are now generally followed up closely and a great deal of attention is given to the details of design in order to make each part strong enough. Those who are following up these matters, as well as the designers of new equipment, find Mr. Cole's articles helpful and suggestive.

Not the least important principle that Mr. Cole brings out is the necessity for sizes of parts that will keep the fiber stresses within safe limits. It has been said that time spent upon designing details of locomotives was wasted, because if the bearing areas are sufficient to prevent heating the strength is sure to be ample. This has been true in the past, and it may even now apply to light engines, but it does not hold good in the heavy engines of present practice. It is evident that locomotives are continually becoming more difficult to design as the requirements become more and more exacting, and the thorough methods of most foreign locomotive men in looking after details may well be copied here. This suggestion is supported by the table of fiber stresses in crank pins and driving axles, derived from foreign locomotives given by Mr. Pomeroy in this issue. It is clear that comparatively low-fiber stresses in these parts are more general in the engines given in this record than will be found in those of this country. The relative number of failures representing the different conditions is not known, and while it may be said that locomotive parts are subjected to so many stresses that are not subject to measurement or calculation as to upset all computation, there is every reason for providing for all of the known factors and leaving good judgment to attend to the unknown.

The present tendency is to relieve enginemen of all care of the machinery, and soon they will do little except to run the engines. Formerly they were required to attend to many adjustments and were held responsible for "their own engines" as regards many minor repairs; they were also required to report defects that they could not fix, and this they were much better able to do before the days of pooling. If engines are to be kept in condition for their best service something will need to be done to enable enginemen to report intelligently upon necessary repairs and adjustments. When they did more work upon the engines they knew better when that work was necessary. On one extensive road this tendency is offset by the traveling engineers, who spend a great deal of time in instructing the younger men as to the proper working of the engine, as well as in reporting defects, and the results are gratifying. Every improvement that will reduce the amount of running repairs, and especially those that will prevent breakdowns, mean cheaper operation for the same reason that pooling does. Moreover, a locomotive large enough to cost \$15,000 must be kept at work or it represents no saving over lighter and less costly ones.

That there is something to be gained from heating feed water by steam after it has done its work in the cylinder is generally admitted, and it is easy to see that much of the heat ordinarily thrown away in the exhaust may be saved by passing it into the feed water. It is generally considered that the saving may be easily calculated and that it is represented by the heat units actually gained by the feed water. This difference of temperature is only a part of the gain, because by heating the feed water the entire contents of the boiler are in a more favorable condition as to its heat-absorbing ability. A boiler seems to work more economically when it is not required to heat as well as evaporate water. Feed water heating is as old as the steam engine and was used by Watt. It has always been considered desirable and is more properly appreciated now than ever before. Two articles in this issue furnish reasons for looking into the subject carefully.

An idea which has much to recommend it is being worked out on the Atchison, Topeka & Santa Fe in holding the division superintendents responsible for the conduct of business on their divisions or districts. They are required to follow up the work of other departments in their territory and are practically general managers of the portions of the road under their charge. An excellent result of this plan is that all subordinate officers are brought to see the relations of one department to another in a way which is likely to broaden their ideas and enable them to contribute their part of the operation of the road intelligently with a view of the important ultimate object of increasing net earnings. This has a tendency to prevent any one department from considering that it has any interests of its own aside from the general good of the whole. It may be said that division superintendents cannot be expected to understand the use of fuel and other similar details and that they should not be held responsible for them. Here is the nub of the whole idea. The best use of fuel can be obtained only through the co-operation of the operating officers. The same principle applies in other matters, and if this theory is carried out the division superintendent will be a very important officer and not merely a good train master or dispatcher.

The difference between the operation of the Diesel motor and the Otto gas engine does not appear to be generally understood, if we are to judge by remarks recently heard in a conversation on internal combustion engines. The first stroke of the Otto gas engine draws a mixture of air and gas into the cylinder, the second stroke compresses it, at the beginning of the third stroke it is exploded, and during the third stroke the piston is driven forward as a result of the explosion, while the fourth stroke expels the burned gases from the cylinder. The operation of the Diesel motor is entirely different. The first stroke draws air into the cylinder, the second compresses it to about 600 lbs. per square inch, at the commencement of the third stroke oil is forced into the cylinder against the high pressure by means of a small auxiliary pump driven by the engine and is immediately exploded by the heat generated by the compression, the piston is driven through the third stroke by the force caused by the burning oil, and the product of combustion is expelled during the fourth stroke. The air compressed by the pump referred to is also used in starting the engine, and this gives the Diesel motor an advantage over others by being always ready to start. The advantages of this motor have been summed up as follows: Simplicity, specially as regards regulation, automatic ignition of the gas without requiring any mechanism for this purpose, regularity of operation under varying loads, good design of oil injecting device, whereby the oil is completely consumed, extreme cleanliness, and the ability to start instantly at any time. The consumption of petroleum, according to Professor Schroter, given in a paper last year before the Institution of Civil Engineers (England), is 0.524 pound per brake horse-power and 0.396 pound per indicated horse-power per hour.

The superiority of steam boiler construction in England, when compared with that of this country, is commented upon by the "Mechanical Engineer" of Manchester, England, in connection with the proposed standard specifications of the American Boiler Manufacturers' Association, the prevalence of punched holes or rivets being one of the features of our practice that is surprising. This critic is rather severe, but it must be admitted that there is justice in such remarks as the following: "Any engineer, however familiar with good English boiler work and methods of construction, must feel, on perusing the standard set forth by American makers, that it permits, and in a measure officially recognizes, methods and practices which no first-rate maker on this side would care to defend." Notable exceptions may be quoted, but the association is on record as to what must be considered common practice in this country. The type of boiler has much to do with the degree of care required to make it tight and safe, and the rather general use of large and thick shells in England demands more careful work than our smaller and thinner ones, but this is merely a defense and not a justification. Greater care in boiler making will pay for the additional cost, and if stationary practice is brought up to the high standard of locomotive work in this country our contemporary will have reason to commend rather than criticise. Well-supported opinions of this kind cannot but improve our boiler making.

NECESSARY IMPROVEMENTS IN CAR CONSTRUCTION.

In an admirable paper recently read before the Western Railway Club, Mr. F. M. Whyte, Mechanical Engineer, Chicago & Northwestern Railway, showed a number of possible improvements in the under-framing of car bodies which should have the attention of car builders. Mr. Whyte assumes that the bolsters should be stiff enough to carry the whole load on the center plates without deflecting enough to bring the side bearings together. He remarks upon the efforts, some of which have failed, to get sufficient strength without exceeding proper limits of weight, and makes the following proposition: That the present general practice of framing cars may be changed so as to distribute the load to the bolsters, and particularly to the body bolsters, in a way that will be more favorable to the bolsters.

The difficulties presented by the truck bolster are not as great as with the body bolster, because the former is not restricted within such narrow limits of depth as the latter, and it is also much shorter. The two must be considered together, however, and the author of the paper remarks upon the practice of using substantial truck bolsters under very weak body bolsters, and says that cars at present are generally weakest at the body bolsters. There would be no difficulty if the load could be transmitted to the bolsters directly over the center plates, and the author shows how the usual arrangement of sills, needle beams and truss rods may be changed to transmit the loads more favorably.

The stresses from the side sills are most unfavorable, and those from the center sills are most favorable, therefore the center sills should be made to transmit as much and the side sills as little as possible. The intermediate sills are a part of the floor, and their location does not affect the proportion divided between the side and the center sills, which is the important factor. The location of the truss rods does affect this, however, and he suggests placing them upon each side of and close to the intermediate sills. It is obvious without calculation that this arrangement will bring the heavy stresses nearer the center plate than the usual plan with two of the truss rods at the inside faces of the side sills. Mr. Whyte then suggests that if the center sills rest upon the needle beams it is possible that some of the load that ought to be carried by the center sills directly to the center of the bolster may be transmitted through the needle beams to the truss rods and to the bolster at a considerable distance from the center,

which is, of course, objectionable. If the center sills are not allowed to touch the needle beams, and if the latter members receive the loads from the side and intermediate sills only, the bolsters must be more favorably loaded, especially if the outside truss rods are brought inside of the intermediate sills. Another and better method is to "locate a truss rod either inside or just outside of each center sill and another truss rod at the inside of each intermediate sill, or even closer to the center of the bolster." This necessitates stiffening the needle beams to prevent them from bending between the side sills and the outer truss rods.

That the form of the upper framing has to do with the failure of bolsters has not escaped notice in the paper, and it is shown that the diagonal bracing of the ends of the car should be inclined at such an angle that it will carry the thrust to the center sills instead of to the side sill. If the braces are used in the customary way, tension rods may be put in parallel to the braces, and they will transmit some of the load from the side sills to the end plates, and through the end posts to the center and intermediate sills.

The desirability of always carrying the load upon the center plate instead of purposely allowing the side bearings to run in contact and provide friction reducing side bearings is debatable, but Mr. Whyte has contributed very valuable and logical suggestions that should be considered, whether side bearings are purposely allowed to come into contact or not. A stiff bolster, carrying the load upon the center plate, seems to have the greatest number of advantages, and Mr. Whyte's plan will be useful to get the strength without too great weight. We have shown the importance of improved side bearings, and it is evident that they must often come into contact. This and the increasing weight of the cars, are reasons why some friction reducing form should be used.

It seems necessary to remark that center plates are now very heavily loaded, and that they must be made larger or relieved in some way from the heavy pressures now used. This has had very little attention, and it is more important with every increase in the capacity of cars.

NOTES.

The plans for the four new monitors for the U. S. Navy have been changed, and as adopted by the Board of Construction they will have single turrets, each containing two 12-inch guns, but the length of the ships is to be increased 27 feet, which allows 200 tons more coal to be carried. The sum of \$103,145 has been agreed upon by the contractors as compensation for the additional requirements above the prices already established.

A convenient valve for pneumatic track sanders, devised by Mr. Theo. H. Curtis, of the Nickel Plate, is described in a recent issue of the "Railway Master Mechanic." It is mounted upon the top of the Westinghouse engineer's brake valve and the advantage it offers is that of convenience in application of the sand, either simultaneously with or independent of the air brake. The pneumatic sander has two valves, one for ordinary use and the other for emergency applications of the brakes.

The preparation of waste for lubricating the journal boxes of freight cars has received careful attention by many master car builders. Mr. J. J. Hennessey, of the Chicago, Milwaukee & St. Paul, has fitted up an old box car body at West Milwaukee with oil tanks and soaking racks, using no free oil in the journal boxes. The waste is soaked in a tank of oil for 36 hours. The surplus oil is then drained out upon sloping racks for four or five hours and the oil is used over again for more waste. The waste becomes thoroughly soaked in the oil and the result is better lubrication, fewer hot boxes and a great saving of oil. The amount of oil used for cars that are repaired and those built at these shops is one-fifth of that formerly required when the oil was poured into the journal boxes. The old car is heated by steam to a temperature of 70 degrees.

An 8-inch Gatling one-piece cast steel gun was tested at Sandy Hook Dec. 15, and the results are reported to be satisfactory. Dr. Gatling expects this gun to be made at about one-half the cost, and in much less time than the built up guns now used. The steel is given a whirling motion in pouring, for the purpose of carrying impurities toward the center, from which they may be afterward removed by boring. The casting is made with a large sink head to give a compression to the material, and the inside is cooled first in order to give an initial tension to the outside portions. The reports of the trial show that the gun withstood a pressure of 37,000 pounds per square inch.

Signaling systems on railroads in which the colors of lights permit of mistaking crossing gate or other lights for fixed signals are not uncommon, in spite of the fact that the dangers are known. The expense and bother of changing a system of lights is sufficient excuse for continuing their use until some accident occurs. Green has been selected as the safest signal for "all clear" indications, and yet many roads stick to white lights. The Whittenton Junction accident on the New York, New Haven & Hartford, which resulted from an engineer's mistake in taking a white gate light for a clear signal from a semaphore, has led to a decision to change to green for "all clear" on that road.

The shells used by the United States Navy, the guns for firing them and the powder charges for each are given in the following table, for which we are indebted to "Engineering News":

Designation—	Shells.				Guns.				Total cost of firing
	Diam. Inches.	Wt. Lbs.	Length Inches.	Charge Lbs.	Wt. Tons.	Length Feet.	Charge Lbs.	once.	
1-pdr.....	1 3/4	1	3 3/8	200*	100 lbs.	5	—	—	\$1.12
3-pdr.....	1 3/4	3	6 1/2	900*	500 lbs.	7	—	—	—
6-pdr.....	2 3/8	6	8 3/4	1,400*	920 lbs.	9	—	—	5.70
4-in.....	4	33	12 1/4	2	1 1/2 tons	14	14	—	—
5-in.....	5	50	16 3/4	3	3 3/4 tons	17	30	33.00	—
6-in.....	6	100	20 3/4	4 1/2	6 tons	21	50	40.00	—
8-in.....	8	250	22 3/4	11	15 tons	29	115	65.00	—
10-in.....	10	500	30	20	28 tons	31	240	—	—
12-in.....	12	850	36	40	45 tons	37	425	—	—
13-in.....	13	1,100	42	50	60 tons	40	550	296.00	—

*Grains.

Note—For 13-in. armor piercing projectiles the total cost of firing is \$588.00.

Comparative costs of the three principal systems of street car operation are given by the "Railroad Gazette" from the report of the Metropolitan Street Railway of New York for the year ending June 30, 1898. The car miles were: Cable, 11,991,000; electric, 7,110,000; horse 15,995,000.

	Cable.	Electric.	Horse.
Maintenance of way.....	\$3.54	\$0.33	\$0.72
Maintenance of equipment.....	0.94	0.83	0.39
Power	2.02	1.70	6.40
Transportation	7.78	6.15	8.49
General expenses.....	2.07	1.22	1.87
Totals.....	\$16.35	\$10.23	\$17.87

If the cable car miles had been run at the cost of the electric working, the saving would have been \$745,840 in the year, or 4 per cent. on \$18,646,000. If the horse-car miles had been run by electricity at the cost as given in the table, the saving would have been \$1,220,000, or 4 per cent. on \$30,500,000. This is the best commentary we have seen upon the advantages of electric traction.

Since the discussion of the subject of broken stay bolts before the Master Mechanics' Association in 1897, the stay bolts of locomotive boilers have come in for more attention than formerly. It will be remembered that Mr. T. A. Lawes at that time showed conclusively that partially broken bolts could not be detected by the hammer test; in one case where three inspectors in turn examined a firebox and found four broken stay bolts the drilling test disclosed 46 others partially broken. The best practice now is to drill the ends of all stay bolts or use hollow stays, but too much reliance should

not be placed upon this means for automatically detecting broken bolts; these holes must be cleaned at frequent intervals or they are useless. Our attention was called to this fact a few days ago by a Superintendent of Motive Power, who had found in cutting out a firebox between 150 and 200 stay bolts wholly and partially broken, and, although these had telltale holes in the ends, none had shown any signs of leakage.—“Railroad Gazette.”

FIBER STRESS, DRIVING AXLES AND CRANK PINS,
FOREIGN PRACTICE.

By L. R. Pomeroy.

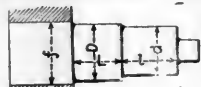

A careful study and analysis of American practice as regards the dimensions of crank pins and driving axles, from the standpoint of fiber stress, has led the writer to examine foreign practice, with a view of ascertaining how their methods compare with ours. Research in both cases has been confined to designs where the power of the piston is delivered on

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
NINETEENTH ANNUAL MEETING.

The annual meeting of this society was opened in New York Nov. 29, President C. W. Hunt in the chair, the first session being devoted to the address of the President. This was a tribute to the engineer, and gave a broad view of his duties, responsibilities and pleasures. At the next session the routine business was disposed of. The committee to confer with the Master Mechanics' and Master Car Builders' Associations on the subject of standard pipe unions, had been obliged to ask for more time. The council had considered a change in the requirements for admission of members on account of the existing rule which gives the veto power to a small and diminishing proportion of the membership. It had also appointed a committee to report on the standardization of methods of testing steam engines. The fireproofing tests had been discontinued by the committee having it in hand, because of lack of funds.

A communication was read from the Institution of Civil Engineers, England, offering the courtesies of the house of the Institution to the members of the American Society who may visit the

FIBER STRESSES, DRIVING AXLES AND CRANK PINS, FOREIGN PRACTICE.

R. R.	Type of Locomotive.	Cyl.	Boiler Pressure.						Fiber Stress.								Distance from Center Line Through Cyl. to Center of Journal.	Fiber Stress at E (lbs.)
				f	D	L	d	l		A	B	C	D	E	F	G		
1 Great Northern, England.....	Atlantic 4-coupled	INS 19x24	175	7	6	3	5	5	12,900	INS. 7 1/4	INS. 9	INS. 9 1/2	INS. 8 1/4	INS. 8 1/4	INS. 16 1/2	15,200		
2 N. S. Wales (Beyer, Peacock & Co.)	4-coupled	21x26	160	6 1/2	6 1/2	5 3/4	5	6	17,900	7 1/4	10 1/4	9	8 1/2	7 1/2	21,300			
3 Mexican Ry. (Neilson & Co.).....	6	18 1/2 x 25	175	6	5 1/2	4 1/2	5	4 1/2	19,000	6 1/2	9	8 1/2	8	7 1/2	19,000			
4	8	18x26	165	6	5 1/2	5 1/2	5	4 1/2	15,800	6 1/2	9	3/4 8 1/2	8 1/4	7 1/2	14,500			
5 Mercy R. R. (Kitson & Co.).....	6	19 1/2 x 26	150	6 1/2	5 3/4	4 1/2	4 1/2	5	18,700	6 1/2	10 1/4	8	7 1/2	7 1/4	22,000			
6 North London (J. C. Park).....	6	17x24	160	5 1/2	5	5	4 3/4	4	20,000	6 1/2	8	8	7 1/4	7	18,000			
7 Sou. of Italy (Neilson & Co.).....	6	20 1/2 x 26	117	6.69	5.9	4	4.3	5	16,300	6 1/2	8	8	8.61	7.48	25,800			
8 Highland Ry. (Sharp, Stewart & Co.)	8	20x26	170								7	9	8		21,000			
9 Indian State Ry. (Neilson & Co.).....	8	20x23	180	6 1/2	6 1/2	5 3/4	5 1/2	5	17,000	6 1/2	10	9	8 1/4	8	20,100			
10 Gt. Northern (P. Stirling)	1 pr. drivers	18x28	160							7 1/4	8	3/4 9 1/2	8 1/2	8 1/4	13 1/4			
11 Soudan Mil. Ry. (Neilson & Co.).....	8-coupled	17x23	160									3/4 9 1/2	8 1/2	8 1/4	9 1/4			
12 Cape Gov. Ry. (Dibbs & Co.).....	6	17x26	160		4.75	4	4.25	5	22,000			7 1/2	7	6 1/2	16 1/2			
13 Grand Central (Belgium).....	6	18.9x23.6	112		5.1	4.3	5.1	5.1	20,000			7.5	6	6.5	17			
14 Northern (France).....	4	23.6x23.6	142							6.69	9.45		6.69		18.9			
		18.1 x	180							7.08	9.44	0.78	7.48	7.08	16.3			
15 Prussian State(Compound).....	6	26.8 x 23.6													18.1			
16 Jura Simplan (Swiss).....	4	16 14x24.1	150	5.3	4.9	3.34	3.9	4.1	13,700	6.14	6.49	0.98	7.08	6.49	15.19			
17	6	17 17x25.59	150	6.10	6.10	3.74	3.93	4.32	9,700	6.89	8.84		8.07	7.48	18.1			
18 Central	6	19 68x24.8	150	6.69	5.50	4.30	4.50	5.28	19,000	6.69	9.80		7.87	7.87	18.9			
19	6	17.7x23.6	150	6.49	5.31	3.30	4.72	6.48	15,800	6.41	9.84		7.08	7.08	18.5			
20 Union	6	17.7x25.59	150	5.90	5.51	3.74	4.74	4.32	13,300	6.89	8.84		8.07	7.48	18.1			
21	8	19.68x21.26	130	5.90	5.51	3.93	4.30	4.21	16,700	5.90	7.87		6.49	6.49	16.29			
		17.7 x																
22 " (Compound, Swiss).....	6	25.19 x 25.59	170	5.90	5.51	4.88	4.70	5.90	20,000	7.32	10.24	0.78	8.07	7.48	19.50			
23 St. Gothard	8	20.47x24	180	6.29	5.90	4.88	5.10	4.30	19,800	7.08	9.44		8.26	7.87	24,000			
24	8	20.4x24	149	6.29	5.90	1.68	5.90	3.90	15,600	7.08	9.44		8.26	7.87	14,22			
25 Imperial Japanese.	6	13x18	140		4	4 3/4	3 3/4	3 3/4	18,600	5 1/2	6 1/2		6 1/4	5 1/4	14 3/4			
		15 1/2 x																
26 Finland State Richmond Comp'nd	6	25 1/2 x 20 1/2	170		5	4 1/2	4 1/2	4 3/4	17,800		7 1/2		6 1/2	5 1/2	16 1/2			
27 Eastern (France).....	4	18.5x25.98	170	6.5C	6.30	5.43	5.70	4.9	14,800	7.08	9.05		8.66	7.67	20.5			
28 Northern	8	20.86x25.59	142	6.89	6.69	4.21	5.78	5	11,500	7.28	9.80	1.4	8.19	8.77	23,800			

the outside bearing of the pin, as is the case with moguls, 10-wheelers and the so-called Atlantic types of locomotives. In this case the question governing the design is one of fiber stress, and not the bearing surface. Because, if the dimensions are large enough to bring the fiber stress down to a safe minimum, the bearings will be plenty large enough from the bearing standpoint, other things being equal.

Such a comparison of foreign locomotives, however, is rather hard to get, for the reason that there are so few types of engines used abroad with outside cylinders, where the conditions are fairly comparable, and by dint of careful searching among the proceedings of foreign technical societies and the foreign technical press the writer succeeded in finding 28 cases, which are represented in the annexed table. This table is also interesting from the fact that it shows incidentally the form of pins and driving axles. The conventional drawing of the driving axle illustrates the prevailing practice abroad of increasing the size of the wheel fit, and also the form of collar used inside of the driving box. It is also quite common to introduce a collar on the opposite side of the box, which is fitted into a counterbore in the wheel fit. The method of calculating the fibre stress is according to the plan illustrated on page 211 of the June, 1898, issue of the "American Engineer."

Paris Exposition in 1900. The finances of the society were shown to be in a satisfactory condition, the total receipts for the year being \$2,406.87, the disbursements \$31,755.82, and the amount due the society \$3,364.67. The first committee report was that on the testing of materials, and Mr. Henning stated that the society was now represented by membership in the International Association.

The professional reports and papers are too long to be presented in our pages, even in abstract, and as they may be had in printed form from the secretary for a small expense, we shall refer to them but briefly.

Revision of the Code for Boiler Trials.—This is a very voluminous report, and the additions to the previous work consist in including the use of recent forms of calorimeters, and covering the analysis of flue gases and stating the efficiency of the boiler. The report will be acted upon at the next meeting of the society.

Strength of Wheel Rims.—Mr. A. K. Mansfield showed in this paper that instead of adding strength to a wheel the ribs that are often put along the edges of the rims are a source of weakness. A deep rib at the center of the wheel was preferred.

Bursting of Small Cast Iron Flywheels, by C. H. Benjamin. —This paper recorded tests by the author on 17 small model wheels. Rim joints between the arms were considered serious defects and flywheels with solid rims, with the usual number of arms and proportions commonly used by engine builders were

considered safe at a rim speed of 100 feet per second, providing good iron was used and cooling stresses avoided. The best of the discussion was by Mr. John Fritz, who stated that there was no defense for a burst flywheel. He referred very modestly to his experience, in which he had designed a large number of flywheels and none of them had failed. He preferred a hollow rim and hollow arms, and did not believe in using metal where it added weight without giving additional strength. The rim joints were made half way between the spokes and were held by links, the slots for which were compensated for by adding material to take the place of that displaced for the links. True running was important, and a wobbling wheel was a dangerous one.

Improvements in Steam Boilers and Their Settings, by W. B. Le Van.—This was a description of a horizontal fire tube boiler, especial care being taken to secure the proper admission of air and to utilize as much of the shell as possible in the form of heating surface. The discussion was almost savage, taking the ground that the ideas were old. One member thought that the author was courageous to champion the fire tube boiler at this late day. The author replied that because a thing was not new it was not necessarily bad.

Use of Steam by Anthracite Mining Companies in Pennsylvania, by R. V. Norris.—This is a record of wastefulness of steam that is remarkable and instructive. The author describes, by aid of indicator diagrams, the condition of the engines at these two mines, and relates that by such work as repairing the

that the coals lost about one-half of 1 per cent. of their calorific power in that time by weathering.

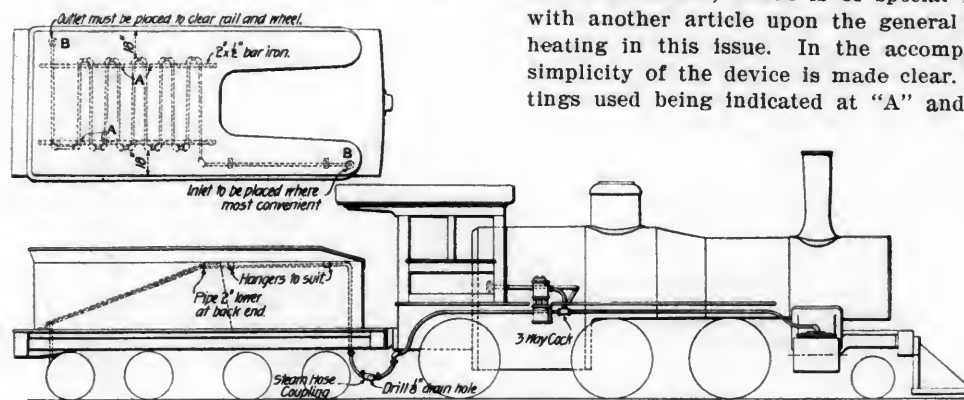
Mechanical Plant of a Modern Office Building, by W. H. Bryan.—This is an interesting record of the design of the entire mechanical plant of a large retail store, and gives the author's figures and specifications for the work. It is a valuable record for those who have work of this character to do, and brought out considerable discussion. A great deal of data are given and the author's methods are outlined. The variety of subjects arising in this problem is striking.

Flow of Steam in Pipes, by R. C. Carpenter and E. C. Sickles.—This paper describes experiments carried out at Cornell University, and from them formulas are worked out to fit several sizes of pipe. The discussion took the form of criticism of the work because the tests were too few to justify such formulas.

The meeting was successful, and while the papers were, as a rule, not remarkable, the discussions were valuable. The next meeting will be held in May, 1899, at Washington, D. C.

HEATING FEED WATER FOR LOCOMOTIVES.

At a recent meeting of the Western Railway Club, Mr. E. M. Herr, formerly Superintendent of Motive Power of the Northern Pacific, gave some interesting and valuable information in regard to the heating of feed water for locomotives by use of the exhaust steam from the air-brake pump. We show the construction of the tank heater referred to, and reproduce Mr. Herr's statement, which is of special interest in connection with another article upon the general subject of feed-water heating in this issue. In the accompanying engraving the simplicity of the device is made clear. The only special fittings used being indicated at "A" and "B." The former is



Feed Water Heater—Northern Pacific Railway.

steam piping and setting valves he was enabled to save enough steam to permit of shutting down twenty boilers at one of the plants and six boilers at the other.

Valve Gear of the Willans Engine, by John Svenson.—This is a complete and valuable description of the Willans engine, including the central valve gear. The discussion brought out the fact that although the rotative speed of these engines is high, being from 300 to 500 revolutions per minute, the short stroke keeps the piston speed down to about 500 feet.

Cooling Tower and Condenser Installation, by J. H. Vail.—This is a description of a cooling tower added by the author to an electric lighting plant in order to increase its capacity without adding to the boiler power. The plant had 27 boilers, 48 inches in diameter, and 20 feet long, and by the addition of the condenser and cooling tower the power was increased by 1,000 horse-power, and there was now steam to spare.

Methods of Testing Indicators, by D. S. Jacobus.—The author directs attention to faulty methods of testing indicator springs, among which is the comparison with the mercury column. He illustrates apparatus for testing that will give the same lines in ascending as in descending pressures when the instrument is in proper condition.

Variations of Belt Tensions with the Power, by W. S. Aldrich.—The paper is a study of the experiments made some time ago by Messrs. Wm. Sellers & Co., and presented in a paper to the society by Mr. Wilfred Lewis. The results of the experiments are plotted in curves and a formula is devised to accord with them.

Calorific Power of Weathered Coals, by R. S. Hale and H. J. Williams.—This is a record of comparisons between samples of coals that had been exposed to the weather for eleven months and samples of the same coals that had been sealed up during that time. The tests by the Williams bomb calorimeter showed

a $\frac{3}{4}$ by 1½-inch clamp, and the latter is a flanged coupling. Mr. Herr's remarks were as follows:

"The last eighteen engines that we built for the Northern Pacific under my jurisdiction had pipes leading from the exhaust side of the air pump through the tank, and in order to get rid of any possibility of oil giving trouble in the tank, the pipe did not deliver the steam into the tank; the water of condensation dropped upon the roadbed after passing through the coil of pipe in the tank. The arrangement of this pipe was as follows: It was brought up on the right-hand side, right next to the tank valve and vertically to the top of the inside of the tank. From this point it extended toward the back and downward in a gradual slope, and zigzag across the tank the width of one water leg until it finally passed through the tank near the back. As the water in the tank got lower, the heating surface exposed to it was continually reduced, and the amount of heat going into the water was correspondingly less; consequently, there was less liability that the water be heated to too high temperature. When the tank was full, of course the water came in contact with more heating surface and more heat was absorbed by it. If the engineer ever did get caught with water so hot he could not work the injector, it always occurred with the right-hand injector first, because the pipe went into the right side, entering near the feed valve opening. In such a case he could always readily start the left-hand injector, because in the left leg of the tank there is no heating pipe, and there is a considerable reservoir of cold water which could be used in an emergency, and would supply cold water enough to be used by the left injector until the next water station was reached. I was surprised to find that

there was very little difficulty of this kind on these passenger engines; there were sixteen of them hauling through passenger trains, doing pretty heavy service, and the engineers ran their exhaust in the tank continuously, very seldom having to divert it on account of the water getting too hot; that happening only in very hot weather. In the Fall and Spring, and, of course, throughout the Winter, there would be no occasion for them to change the exhaust from the tank. This is a very important factor in saving of fuel, as can be very clearly seen when one considers that, as I believe the authorities estimate for every 11° rise in the temperature of feed water there is a saving of about 1 per cent. of coal used in the generating of steam. This is a theoretical consideration, but I thought we could notice in the fuel consumption and in the steaming of the engine in bad weather a very undoubted and practical advantage. In practice the temperature was rarely raised above 90°, and 90° is about the limit at which an ordinary injector will handle water. I did a great deal of experimenting with different makes of injectors to find out which would handle the hottest water. If, as seems to be the case, one can effect a saving of 1 per cent. of coal for each 11° increase in temperature of feed water by reason of using the exhaust steam, we certainly should get that injector which will handle feed water at the highest temperature possible, and obtain this economy. By experimenting, I found one injector that would handle feed water at a temperature of 124°."

LOCOMOTIVE DESIGN—THE WORKING STRENGTH OF MATERIALS.

By F. J. Cole, Mechanical Engineer Rogers Locomotive Works.

PARALLEL OR SIDE RODS.

The consideration of what design is the most suitable for a part or member of a machine is often of as much importance as the material from which it is made. A notable instance of this may be cited in the case of the parallel or side rods coupling together the different pairs of driving wheels.

Fifteen or twenty years ago rods of rectangular form were in general use; some were of uniform section and others deeper and thinner in the middle, tapering down to the normal size at the ends next the crank pins. The long rods of this style used on eight-wheel engines having two pairs of driving



Fig. 1.

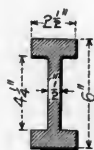


Fig. 2.

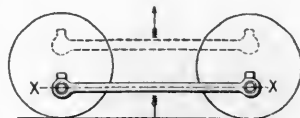


Fig. 3.



Fig. 4.

wheels and a four-wheel truck—commonly known as the "American type"—were continually breaking, the position of the fracture generally lying in the central portion of the rod. Imagine the rod divided into three equal parts, then the majority of fractures would occur somewhere in the central part, towards the ends. Increasing the size of the rods decreased slightly the number of breakages. Making the center deeper and thinner was a much greater improvement, but was only a step in the right direction.

The general opinion was that fractures were liable to occur whenever the pedestal wedges were improperly adjusted or when, from other causes, the engine got "out of tram," as it is commonly called; that is, increasing or decreasing the distance between the centers of the driving wheels until they measured or "trammed" more or less than the length between the centers of the crank pins. This would throw a great strain on the frames, rods and crank pins, as the engine passed over the centers, and might, under extreme conditions, run up the stress far beyond that produced by the steam pressure.

Indeed, so general was the belief that the rods might break at any time, that it was customary to protect the engineman in the cab by lining the under side of the running board or floor with heavy iron plates, 3/8 inch or more in thickness, to "armor plate" it, so to speak, to resist the blows which the ends of the broken rod would shower upon it if the accident occurred when the engine was running at a high rate of speed. It was no unusual sight to see engines which were not so protected with one side of the cab badly wrecked from a broken rod. The idea that it was possible to calculate accurately the strains to which a parallel rod was subjected was received at first with incredulity by the older class of railroad mechanical men.

Even with the best form of rectangular section; that is, one deep and thin in the center of, say, 1 1/2 by 6 inches, Fig. 1, the sectional area would be 9 square inches, with a weight of 30.6 pounds per foot, and a section modulus of $\frac{bd^2}{6} = 9$. An I-

section, 6 inches deep and 2 1/2 inches wide, Fig. 2, would have a sectional area of 6.5 square inches, a weight of 22.1 pounds per foot and a section modulus = 10.73. The advantage then of the I-section is apparent at a glance. Not longer than 10 or 11 years ago* the fact gained wide acceptance that the centrifugal force caused by far the greatest stresses which the rod had to bear. After this the use of I-section rods, which had been slowly coming into use, increased very rapidly, and at the present time nearly all fast running engines requiring long rods, or those over 5 or 6 feet in length, are designed of I-section, having a minimum weight and a high section modulus. Rods of this description, suitably designed and made of good material, rarely break in service. The forces which produce stresses in the rods under discussion are: (a) The push and pull of the piston; (b) Any variation in the length of the rod from that of the distance between centers of the driving axles and the inequality of the crank pin angles; (c) The unequal adhesion of the driving wheels upon the rails, and (d) The centrifugal force, tending to bend the rod transversely in the vertical plane of oscillation. The last, (d), causes, in certain types of engines by far the greatest stresses which the rods have to withstand, producing alternately tension and compression in the outer fibers of the metal, as the rod, supported only at either end, is thrown upward and downward, reversing the stresses for every revolution of the wheel.

Two general divisions of these forces may also be made—the stresses which may and those which cannot be calculated. Those which may be calculated are the thrust of the piston and the centrifugal force, and those which cannot are the non-parallelism of the rods and the unequal adhesion of the driving wheels upon the rails. The stresses caused by the piston are compression and tension acting in line, lengthwise of the rod and parallel, or coinciding, with its axis x x, Fig. 3.

In an eight-wheel engine of the American type half the piston thrust is normally transmitted to the rear wheel

$$D^2 .7854 P$$

through the parallel rod. The fiber stress will = $\frac{D^2 .7854 P}{2 A}$,

in which:

D = the diameter of the cylinder.

P = the boiler pressure.

A = the sectional area of the rod.

In a mogul and ten-wheel engine the fiber stress will = $\frac{D^2 .7854 P}{3 A}$.

$$3 A$$

And in a consolidation $\frac{D^2 .7854 P}{4 A}$.

The centrifugal force gives rise to transverse stresses acting in a vertical plane perpendicular to the longitudinal axis of the rod, in a similar manner to a beam supported at both ends

* Problem of the Locomotive Side Bar, J. B. Johnson, R. R. Gazette, Sept. 16, 1887.

and uniformly loaded along its entire length, as shown in Fig. 3.

It is a well established fact that if the known stresses are properly provided for and a suitable factor of safety introduced, that the increase caused by the unknown will not require much attention in the design. The adjustment, however, should be carefully attended to in service. A few moments reflection will make this clear. The amount of metal required to provide a suitable section to resist the centrifugal force and the tension and compressive stresses will give a sectional area so large, comparatively, that the unknown and non-computable forces, which act directly along its length, divided by this area, will be so small, compared to those acting in a direction perpendicular to its length (whose maximum strain is only on the outer fiber) that its addition will not materially affect the problem. It is also probable that the springing of the crank pins and driving axles will, to a great extent, relieve the strain before the danger line is reached. This is more particularly true when the parallel rod is outside the main rod.

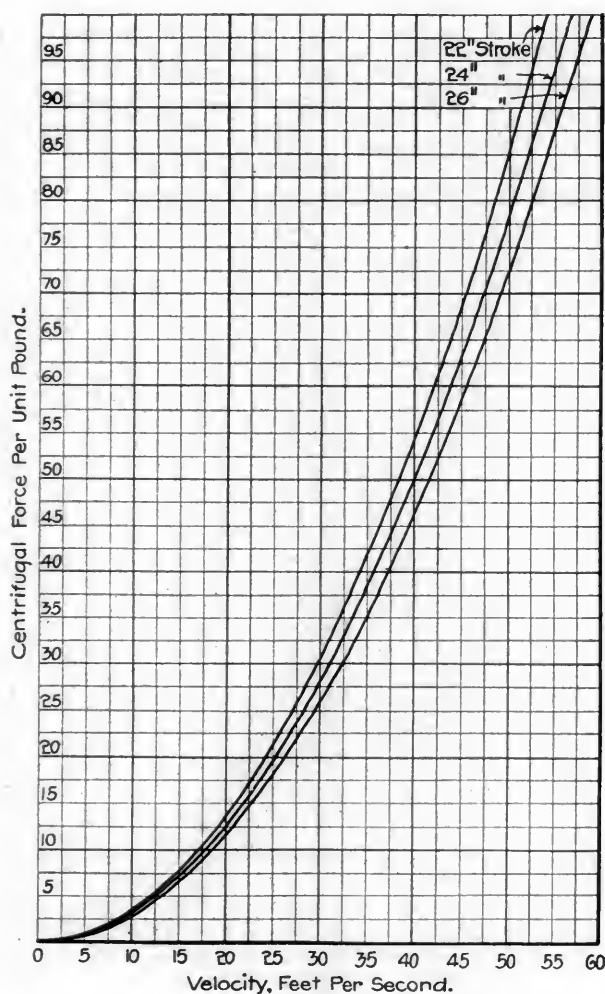


Fig. 5.

For a body moving in a circular path the centrifugal force $F = \frac{W v^2}{r g}$, in which:

W = the revolving weight.

v = the velocity in feet per second.

r = the radius of the circular path in feet.

g = the acceleration of gravity = 32 ft. per second.

For a rod of I section, Fig. 4, the sectional area is 6.56 square inches. The moment of inertia = $\frac{b h^3 - 2 b' h'^3}{12}$. The

section modulus = $\frac{I}{0.5 h}$. Substituting the dimensions of the section, $\frac{23.446}{12} = 23.446$ moment of in-

ertia. $\frac{23.446}{0.5 \times 5.25} = 8.931$ section modulus. Length between

centers of rod = 100 in. Diameter of driving wheels = 68 in. Revolutions per second, at 80 miles per hour, = 6.59. Radius of crank pin circle = 1 ft. Velocity of crank pin in feet per second = $6.59 \times 6.28 = 41.38$. Weight of section per foot = 22.33 lbs. Weight of rod (except ends) = $22.33 \times 8.33 = 186$ lbs. $F = \frac{186 \times 41.38^2}{32} = 9,952$ lbs.

The maximum stress in the outer fibres = $S = \frac{W L}{8 M}$, in

which:

W = the weight of force in pounds, uniformly distributed.

L = the length between centers or pins in inches.

M = the section modulus.

Substituting the known values, $S = \frac{9,952 \times 100}{8 \times 8.931} = 13,929$ lbs.

fibre stress per square inch. Eighty miles per hour is doubtless a higher speed, and consequently a greater centrifugal force than is reached in actual service. It is not probable that a speed of 70 miles per hour is often exceeded with this diameter of driving wheel. The dimensions are taken from a class of eight-wheel American type of engines, a number of which have been running in heavy express service for eight or nine years without any breakages of parallel rods.

The maximum stress in the outer fibres for centrifugal force alone at 70 miles per hour is:

Revolutions per second = 5.766.

Velocity in feet per second = 36.21.

$F = \frac{186 \times 36.21^2}{32} = 7,620$.

$S = \frac{7,620 \times 100}{8 \times 8.931} = 10,667$ lbs. fiber stress.

By the use of the diagram Fig. 5, the centrifugal force for each pound of weight of rod at any given velocity may be read off at once. Take the last example, 36.21 ft. velocity per second. Follow up from the bottom on the vertical lines corresponding to 36.21 until it intersects the curved line marked 24-in. stroke; then follow the horizontal line to the left hand side and read off 41. The rod weighs 186 lbs. and $41 \times 186 = 7,626$ lbs. This gives the centrifugal force within 6 lbs. of that found by calculation.

Table 1 gives the area, weight per foot (steel); moments of inertia, axes, horizontal and perpendicular; least radius of gyration, and the modulus of section for rectangular bars 3 in. to 6 in. deep.

The moment of inertia, axis horizontal, may be obtained for I sections by adding together the proper widths and subtracting the part cut out in the sides. Example, Fig. 4, from the table, twice $1\frac{1}{4} \times 5\frac{1}{4} = 2\frac{1}{2}$ in. $\times 5\frac{1}{4}$ in. The moment of inertia = 30.14 , $\frac{7}{8} \times 3\frac{1}{2}$ in. = 3.12 , 1 in. $\times 3\frac{1}{2}$ = 3.57 . Then $30.14 - (3.12 + 3.57) = 23.45$ moment of inertia. Since the centrifugal force increases or decreases directly as the weight, the rod may often be reduced in size by thinning down or making a smaller section, preserving the relative strength or what is the same thing, a similar ratio between the section modulus and the weight per foot.

The thrust of the piston, transmitted through the parallel rod, equals the area of the piston multiplied by the maximum steam pressure, divided by the number of driving wheels on one side. For an eight-wheel engine of the American type this equals $\frac{D^2 \times 7854 \times P}{2}$, substituting the dimensions of the en-

gine under consideration; (20 in. cylinders and 165 lbs. steam pressure), the force transmitted through the rod is 25,900 lbs. The stress per square inch in tension will equal

$\frac{F}{A}$, in which:

F = the force transmitted.

TABLE I.

		Modulus of section = $\frac{bh^2}{6}$		Moment of inertia = $\frac{bd^3}{12}$		Least radius of gyration = $\sqrt{\frac{I}{A}}$		Least side or 3.46	
Size.		Moment of Inertia. Axis Hor.	Axis Per.	Weight per ft. steel.	Least Modulus Rad. of section of G. Axis Hor				
3/4	3	2.25	1.68	.1054	7.65	.216	1.12		
7/8	3	2.63	1.82	.1675	8.93	.252	1.21		
1	3	3.	2.25	.250	10.20	.288	1.50		
1 1/8	3	3.88	2.53	.356	11.48	.324	1.69		
1 1/4	3	3.75	2.81	.488	12.75	.360	1.87		
1 3/8	3 1/4	2.84	2.50	.1814	9.67	.252	1.54		
1 1/2	3 1/4	3.25	2.86	.2708	11.05	.288	1.76		
1 3/4	3 1/4	3.66	3.22	.3854	12.43	.324	1.98		
1 7/8	3 1/4	4.06	3.57	.5289	13.81	.360	2.20		
2	3 1/2	4.47	3.92	.7039	15.20	.396	2.41		
2 1/8	3 1/2	3.06	3.12	.1954	10.41	.252	1.79		
2 1/4	3 1/2	3.50	3.57	.291	11.90	.288	2.04		
2 3/8	3 1/2	3.94	4.02	.415	13.39	.324	2.29		
2 1/2	3 1/2	4.38	4.46	.569	14.87	.360	2.55		
2 7/8	3 1/2	4.81	4.91	.7580	16.36	.396	2.81		
3	3 1/2	5.25	5.36	.9843	17.85	.433	3.06		
3 1/8	3 1/2	3.75	4.39	.3125	12.75	.288	2.34		
3 1/4	3 1/2	4.22	4.94	.4446	14.34	.324	2.63		
3 3/8	3 1/2	4.69	5.49	.6103	15.94	.360	2.93		
3 1/2	3 1/2	5.16	6.04	.8122	17.53	.396	3.22		
3 7/8	3 1/2	5.63	6.59	1.055	19.13	.433	3.51		
4	3 1/2	6.09	7.14	1.340	20.72	.469	3.81		
4 1/8	3 1/2	6.59	7.69	1.674	22.32	.505	4.10		
4 1/4	4	4.	5.33	.333	13.60	.288	2.67		
4 3/8	4	4.5	5.99	.474	15.30	.324	2.99		
4 1/2	4	5.	6.66	.651	17.0	.360	3.33		
4 7/8	4	5.5	7.33	.866	18.70	.396	3.67		
5	4	6.0	8.00	1.125	20.40	.433	4.00		
5 1/8	4	6.5	8.66	1.430	22.10	.469	4.33		
5 1/4	4	7.0	9.33	1.786	23.80	.505	4.67		
5 3/8	4	7.5	10.00	2.188	25.50	.541	5.01		
5 1/2	4 1/4	4.78	7.19	.5040	16.26	.324	3.38		
5 7/8	4 1/4	5.31	8.00	.6917	18.06	.360	3.76		
6	4 1/4	5.84	8.80	.9205	19.87	.396	4.14		
6 1/8	4 1/4	6.38	9.60	1.195	21.68	.433	4.51		
6 1/4	4 1/4	6.91	10.40	1.519	23.48	.469	4.89		
6 3/8	4 1/4	7.44	11.20	1.898	25.29	.505	5.27		
6 1/2	4 1/4	7.97	12.00	2.334	27.10	.541	5.64		
6 7/8	4 1/4	8.50	12.79	2.833	28.90	.577	6.02		
7	4 1/2	5.06	8.54	.5356	17.22	.324	3.79		
7 1/8	4 1/2	5.63	9.49	.7324	19.13	.360	4.22		
7 1/4	4 1/2	6.19	10.44	.9746	21.04	.396	4.64		
7 3/8	4 1/2	6.75	11.39	1.265	22.95	.433	5.06		
7 1/2	4 1/2	7.31	12.34	1.609	24.87	.469	5.48		
7 7/8	4 1/2	7.88	13.29	2.009	26.78	.505	5.91		
8	4 1/2	8.44	14.24	2.471	28.69	.541	6.33		
8 1/8	4 1/2	9.00	15.18	3.00	30.60	.577	6.75		
8 1/4	4 3/4	5.34	10.05	.5633	18.17	.324	4.23		
8 3/8	4 3/4	5.94	11.16	.7730	20.19	.360	4.70		
8 1/2	4 3/4	6.53	12.23	1.028	22.21	.396	5.17		
8 7/8	4 3/4	7.13	13.39	1.336	24.23	.433	5.64		
9	4 3/4	7.72	14.50	1.698	26.25	.469	6.11		
9 1/8	4 3/4	8.31	15.62	2.121	28.27	.505	6.58		
9 1/4	4 3/4	8.91	16.74	2.609	30.28	.541	7.05		
9 3/8	4 3/4	9.50	17.86	3.166	32.30	.577	7.52		
9 1/2	5	6.25	13.01	.813	21.25	.360	5.21		
9 7/8	5	6.88	14.31	1.083	23.38	.396	5.73		
10	5	7.5	15.61	1.406	25.50	.433	6.25		
10 1/8	5	8.13	16.91	1.787	27.63	.469	6.77		
10 1/4	5	8.75	18.21	2.233	29.75	.505	7.29		
10 3/8	5	9.38	19.51	2.746	31.87	.541	7.81		
10 1/2	5	10.00	20.82	3.333	34.00	.577	8.33		
10 7/8	5 1/4	6.56	15.07	.8544	22.32	.360	5.74		
11	5 1/4	7.22	16.53	1.137	24.54	.396	6.31		
11 1/8	5 1/4	7.88	18.03	1.476	26.78	.433	6.83		
11 1/4	5 1/4	8.53	19.54	1.877	29.01	.469	7.45		
11 3/8	5 1/4	9.19	21.06	2.344	31.24	.505	8.02		
11 1/2	5 1/4	9.84	22.58	2.883	33.47	.541	8.59		
11 7/8	5 1/4	10.50	24.11	3.500	35.70	.577	9.19		
12	5 1/2	6.88	17.32	.895	23.38	.360	6.30		
12 1/8	5 1/2	7.56	19.05	1.191	25.71	.396	6.93		
12 1/4	5 1/2	8.25	20.79	1.547	28.05	.433	7.56		
12 3/8	5 1/2	8.94	22.52	1.966	30.39	.469	8.19		
12 1/2	5 1/2	9.63	24.23	2.456	32.73	.505	8.82		
12 7/8	5 1/2	10.31	25.98	3.021	35.06	.541	9.45		
13	5 1/2	11.0	27.729	3.66	37.40	.577	10.08		
13 1/8	5 3/4	7.19	19.80	.9353	24.44	.360	6.88		
13 1/4	5 3/4	7.91	21.78	1.245	26.88	.396	7.58		
13 3/8	5 3/4	8.63	23.76	1.617	29.33	.433	8.27		
13 1/2	5 3/4	9.34	25.74	2.055	31.77	.469	8.95		
13 7/8	5 3/4	10.06	27.72	2.563	34.22	.505	9.64		
14	5 3/4	10.78	29.70	3.158	36.65	.541	10.33		
14 1/8	6	11.50	31.68	3.833	39.10	.577	11.02		
14 1/4	6	7.5	22.50	.976	25.50	.360	7.50		
14 3/8	6	8.25	24.75	1.299	28.05	.396	8.25		
14 1/2	6	9.0	27.00	1.687	30.60	.433	9.00		
14 7/8	6	9.75	29.25	2.140	33.15	.469	9.75		
15	6	10.5	31.50	2.679	35.70	.505	10.50		
15 1/8	6	11.25	33.75	3.295	38.25	.541	11.25		
16	6	12.0	36.00	4.00	40.80	.577	12.00		

A = the cross sectional area of the rod.

Then $\frac{25,900}{6.56} = 3,948$ lbs. stress per square inch.

Good practice seems to indicate that the normal force transmitted directly through a steel rod, in tension or compression, should not exceed 5,000 lbs. per square inch; that is, the sectional area of the rod should not be less than that proportion of the piston effort which the rod has to convey to the back or front wheels, divided by 5,000. This comparatively low figure may be accounted for when it is remembered that the slipping of one pair of wheels, with sand under the others, may cause the normal force to be increased at least 50 per cent., or considerably more if the crank pins are improperly "quartered."

(To be continued.)

THE CONSTRUCTION OF A MODERN LOCOMOTIVE*.

By T. R. Browne, Master Mechanic, Juniata Shops, P. R. R.

VII.

General Summary of Tools and Their Arrangement.

There is probably no question in connection with the erection and equipment of a new plant more perplexing or more difficult to decide with any degree of definiteness which will carry with it a satisfying conviction that the conclusions are correct or within a very close limit, than that of the selection and arrangement of tools, and we question whether it is really possible to decide except with a degree of relative accuracy on the amount of equipment which will be required, even where an exact and very detailed knowledge of what it is desired to construct exists. Before even approximate conclusions on a question of this kind can be arrived at, after having decided upon the capacity of the proposed works, it is necessary to know the amount of machine work of various kinds which the various parts of an average size locomotive will require, the general character and kind of tools which shall be used, the character and kind of labor which shall be employed in their operation, and the available space for installing this equipment.

The whole operation of machining parts is practically included in the various processes of milling, drilling, planing, slotting, boring, threading, etc., and, as it has been found convenient to pay for these various operations upon a basis of the lineal inches of thread cut or holes bored, the square inches of milling, planing or slotting, calculations for determining these are made accordingly.

We consider that it is a mistake to overlook the fact that shops for the construction of locomotives are as essentially a special plant for the construction of a special product as any other line of manufacture in which one line of product constitutes the largest amount of output, and that the adoption of special tools and equipment for this line of work is fully as important and will bring proportionately as large returns in profit as the adoption of this character of machinery in other special lines. It is believed that there are very many cases where the standard equipment furnished by manufacturers is adopted for the construction of parts in locomotive work where special tools and special facilities adapted to this peculiar line of work would create a much larger profit than the equipment referred to. It is true that a slight variation in design in many cases will necessitate a change of method, but it is also true that, considering a large variety of designs of locomotives, there is a general sameness existing which would in no way interfere, but rather encourage, the general adoption of more special facilities for this character of work than has been generally the case. It is also true that the general character and design of tools is largely a matter of personal preference either on the part of those who are in direct charge of the plant, or, in many cases,

*For previous article see issue of November, 1898, page 357.

of the foreman in charge of the shop in which this equipment is placed, and, considered from this standpoint, the general character of the supervision, its intelligence and discrimination in favor of the most modern methods, will have an important bearing on the economy of whatever equipment may be adopted.

The great improvements which have been made in modern tools and machinery have, to a very large extent, made unnecessary the employment in the operation of this machinery of what are known as "first-class, all-around mechanics," encouraging the use instead of what may be termed a "specialist" class of operatives, who become skillful in connection with the one machine which they operate. This class of men are frequently those who have had no opportunity to learn a trade, but possess sufficient mechanical ability to adapt themselves to one general condition. The earnings which they can make are largely in excess of what they could realize in any other way, and are generally more than satisfactory, although less than the amount which would be required if the machinery were operated by a skilled mechanic. It has been found advisable to consider the skilled mechanic's usefulness as being confined entirely to that class of work which includes the manufacture of small tools and equipment required in a plant of this kind, and the general maintenance of the large amount of machinery operated by specialists, and the return for the amount paid the skilled mechanic in this kind of work, generally speaking, is very much more than would be the case if he were employed in connection with actual production and operation of the various machines throughout the plant.

In previous articles we have laid special stress on the importance of having all of the operations on various parts required in the completed locomotive carried on in such manner as to be steadily progressive, with a view of obviating any retrograde movement, which would mean lost time and additional expense, and we cannot too strongly emphasize the careful consideration of this question in connection with the arrangement of tools and machinery, or the buildings themselves, in a new plant.

The available amount of ground will in many cases necessitate arrangements which, considered from this standpoint, are not perfectly satisfactory, and we can conceive of conditions in which it would be cheaper to purchase the amount of additional ground required for a better arrangement at even a high figure than to provide an expensive installation which, owing to lack of proper arrangement, is a constant expense which, per year, will be found to represent an interest on an investment very much larger than the additional amount required would have cost.

Careful calculations made to determine the total amount of various kinds of finish required on one locomotive, and, considering a locomotive of the consolidation type of about 90 tons weight, with solid forged frames, finished on top and sides and at such other points where parts are bolted on, and in other respects no more finish than is absolutely essential consistent with safety and general economy of maintenance, develops the amounts of machine work given below. For general convenience, we have divided the kinds of work into five distinct parts: First, all of the work which is done in the machine shop; Second, the amount of machine work which is done in the blacksmith shop; Third, the amount of forging done in the blacksmith shop; Fourth, the amount of machine work on boilers in the boiler shop; and, Fifth, the amount of work done in the brass room.

It will be noted that we have only covered the largest operations in these calculations, considering it advisable to avoid as much detail as possible, the object being to furnish a general suggestion rather than an exact detail, and in this respect have not included the tank work, foundry work or wood work. We have also omitted, and, compared with the total average of other work, this is very small, the pipe work and ordinary

sheet iron work, a very large amount of this work being purely labor without an introduction of machines to any very large extent:

Total Amount of Work in Machine Shop.							
Plan- ing. Square inches.	Turn- ing. Square inches.	Boring. Square inches.	Milling. Square inches.	Slotting. Square inches.	Cold- sawing. Square inches.	Drill- ing. Linear inches.	Tap- ping. Linear inches.
77,089	83,419	9,915	13,995	20,116	595	6,852	612

Total Amount of Work in Bolt Department—Blacksmith Shop.		
Turning. Linear inches.	Threading bolts and studs Linear inches.	Threading nuts. Linear inches.
3,363¼	11,421½	2,833¾

Total Amount of Forging in Blacksmith Shop.	
Total amount of forging in blacksmith shop, including forgings of bolt department	61,819 pounds.

Total Amount of Work in Boiler Shop.			
Planing edges of plates. Square inches.	Shearing Square inches.	Punching. Holes.	Tapping. Linear inches.
2,253	2,633	10,915	733

The different divisions of work required in finishing the amount of brass work required for one engine are so small, comparatively, and the large variety of automatic machinery available for this purpose is so large, that we have omitted making any special figures representing the various processes through which this work would go, considering in the light of general information, which it is necessary to have for the larger amount of installation, that this detail would be unnecessary.

Of the various divisions of machine work performed in machine shops 46.3 per cent. of the planing is represented by the work done on frames, cylinders, foot plates, guide yokes, truck plates, frame braces, steam chests, bumper castings and pedestal braces; 64.2 per cent. of the turning is represented by wheel centers, tire, axles, lift shafts, rockers, cylinder heads, pistons and rings, boiler rings, front and extension rings, steam chests, eccentrics and straps; 70 per cent. of the slotting is represented by work required on frames and braces, crossheads, foot plates, bumper castings, guide yokes and driving boxes; 87 per cent. of the milling is represented by guide yokes, crossheads, rods and braces, mud rings, guides, main axles, links and hangers, guide yoke knees; 89 per cent. of the boring is represented by cylinders, crossheads, rocker boxes, lift shaft bearings, lift shafts and rockers; 68.7 per cent. of the drilling is represented by that required for rods, crossheads, holes for pedestal bolts, and cylinders; 65 per cent. of the tapping is represented by that required in connection with cylinders, pistons and the larger parts which are tapped in the machine in which they are drilled.

The difference between the percentages specified, including certain specified kinds of work, and the total of such work includes all of the smaller parts which are capable of being grouped on special machines according to the character of facilities provided; 70 per cent. of the turning on bolts and studs in the bolt department of the blacksmith shop is represented by bolts and studs from 5-16 in. to 1 in., and the balance from 1 in. up; 74 per cent. of the threading is represented by bolts and studs from 5-16 in. to 1 in., and the balance from 1 in. up; 39 per cent. of the tapping required in nuts is represented by nuts from 5-16 in. to 1 in., and the balance from 1 in. up.

The division of the total forging in the blacksmith shop will be about as follows: 58.9 per cent. represents frames, braces, guide yokes, guides, rods, truck plates, pistons, and that class of work which will require hammers of not less than 6,000 to 8,000 lbs. capacity; 20 per cent. represents mud rings, front end extension rings, spring rigging, smoke box braces, piston rods, valve yoke and rods, brake rigging, link and valve motion, crossheads, lift shafts, rockers, and that class of forgings which should not be done on a hammer of less than 3,000 lbs. capacity; 6 per cent. is represented by bolts and forgings of that nature made in the bolt department. The balance includes the smaller classes of forgings, for which, owing to great variety of designs and engines, it is not desirable to construct special

tools or dies, and which are most frequently made over the anvil.

We have implied the use of steam hammers to a large extent in getting out this work, although it is our conviction that a very large amount, if not the entire amount, of the smaller class of forgings, which are comprised under the general headings of crossheads, piston centers, link and valve motion, spring rigging, brake rigging, as well as boiler braces, can be more advantageously made in special dies, and these dies used in a forging press of sufficient capacity. The great advantage of doing the work in this way lies largely in the fact that the dies can be made exceedingly accurate, finely finished, and, owing to the treatment which they receive in the press, will last a long time, the small amount of finish which can be left on this press in many cases making necessary only a process of grinding to complete it. It is a well recognized fact that metal, under a steady pressure, can be caused to assume distorted shapes which any amount of blows in a steam hammer would never produce. It is also true that, even if the attempt were made to use dies for this purpose, in a steam hammer, the life of the dies would be so ridiculously short as to make that kind of a performance an exceedingly extravagant one to perpetuate. A forging machine will almost entirely do away with the necessity of trimming or finishing up work over anvils, as well as greatly reduce the amount of time required to get out the parts required in the blacksmith shop and the time consumed in machining the parts as at present constructed in the machine shop. It is true that in an operation of this kind two sets of dies will be required, one for roughing and the other for finishing, the roughing die roughing the work possibly within $\frac{1}{8}$ in. to 3-16 in. of size, and the finishing die completing it to within 1-32 in. of size. A machine of this type will render the installation of a large number of steam hammers unnecessary. These are always more or less extravagant in consumption of steam and expensive to operate, and we believe that the steam consumed by the pump in providing the necessary amount of hydraulic pressure for operating hydraulic machines will amount to considerably less than that consumed by a sufficient number of steam hammers to get out the same amount of work.

The necessity for sub-division of the different kinds of work performed in the boiler shop by machinery does not exist to the same degree as is the case with the machine shop. In the case of planing, a plate planer which will plane $1\frac{1}{4}$ -in. plate will answer for all others of less thickness. A shear which is capable of shearing $1\frac{1}{4}$ -in. plate will likewise shear plate of less thickness. It is also true in connection with punching that a punch which will take care of plate of this thickness and of holes that do not exceed $1\frac{1}{4}$ in. will answer for lighter work. In the case of tapping, as most of this is comprised in the tapping of staybolt holes, the necessity of sub-division for the purpose of providing tools of different capacity for this work does not exist.

Therefore, in considering the tool equipment for a shop of this kind, the points which would naturally be considered would be the depth of throat of machines for punching and shearing and their power capacity, with reference to the arrangements for doing the work or carrying the work through the shop, the greatest depth of throat generally being required in a machine used for punching holes in flue sheets. This need not in any case be more than from 40 to 45 in. In most cases one double side plate planer capable of taking care of plate up to $1\frac{1}{4}$ in. will be found more than ample to keep up a reasonable capacity.

Obviously, the number of rivets to be driven will be approximately equal to about one-half the number of holes which are to be punched, and the adaptability of riveters to the work which they have to do is proportionate to the length of reach and size of rivet, the largest sizes including one sufficient for firebox work, and a size sufficient to take in the whole length of the boiler, including the front and extension, it being advisable to drive all the rivets by machinery if possible.

In a general sense, all of the tools and equipment can be divided into two classes: That class of tools which in their operation have a reciprocating motion, and spend about one-half of their total time of operation in recovering for the next movement, in which would be included planers, slotters, shapers, steam hammers, bolt machines, punches, shears and riveters, and that class of machinery whose operation is continuous, in which can be included milling machines, drill presses, boring, tapping and threading machinery and lathes. In figuring capacity of tools, an allowance must be made in each of these cases which will represent the lost time of the tool itself, as in the case of planers, representing nearly one-half plus the time required to set and handle the work. Generally speaking, it will be found that about one-half of the time required to turn out a given amount of work is consumed by getting ready, added to the lost time in the machine itself and general handling of parts. Proper facilities in the way of jigs, fixtures, method of handling, as well as a careful adjustment of prices, will go a long way toward reducing this difference, and, with proper supervision of detail, this fact will never be lost sight of, and the greater proportion of time consumed in doing a given amount of work will be that performed by the machine.

We have observed that the output was produced at the lowest possible cost in every case where the time performed by the machine in actually removing material was greater than the time required to prepare the work for this operation.

The adoption of special equipment along similar lines to those adopted by manufacturers of such equipment made in large quantities and on an interchangeable basis will, we believe, in time, almost entirely do away with the necessity for laying off work, and the large amount of rehandling incident to the production of almost every one of the parts of a modern locomotive.

We cannot ignore the fact that the capacity of even the most modern kind of equipment is very largely, if not in some cases entirely, controlled by the operator. His interest is only to get out as much work as he is paid for, and if the adjustment of price is not in the interests of economy or greater output from that particular tool, its output will be represented by exactly what the operator determines it shall be. For this reason the question of deciding as to the number of tools which will be required to do in one day or one month any proportion of the work on one locomotive as we have specified it, becomes a difficult one, and is largely governed by the maximum price per day that it is decided labor shall earn. The personal element, as we choose to term it, in connection with the operation of modern machinery, cannot be eliminated as long as this machinery requires an operator, but we believe that it is a mistake to determine the price to be paid for a given amount of work by the individual skill of the operator who is to do it, and that the capacity of the machine should be considered first, and an operator selected who can get out that capacity.

We have indicated the amount of work of various kinds required for one engine. With any known capacity this will become a multiple of the whole, and the amount of work to be turned out in one day will be proportionate. The number and kind of tools required to turn out this amount of work will be decided by a knowledge of the character and kind of tools available, whose output will be equal to the maximum amount of this with the minimum amount of expense for labor. This will also be governed, to a large extent, by the system of handling and doing the work which it shall be decided to adopt.

The amount of floor space required for a given amount of equipment and for a given amount of work will vary with the character of the work. Obviously, more floor space with a given amount of investment in the tools contained will be required in the boiler shop than would be the case in the machine shop. This would likewise be true in connection with the blacksmith shop.

It is, of course, understood that the investment represented

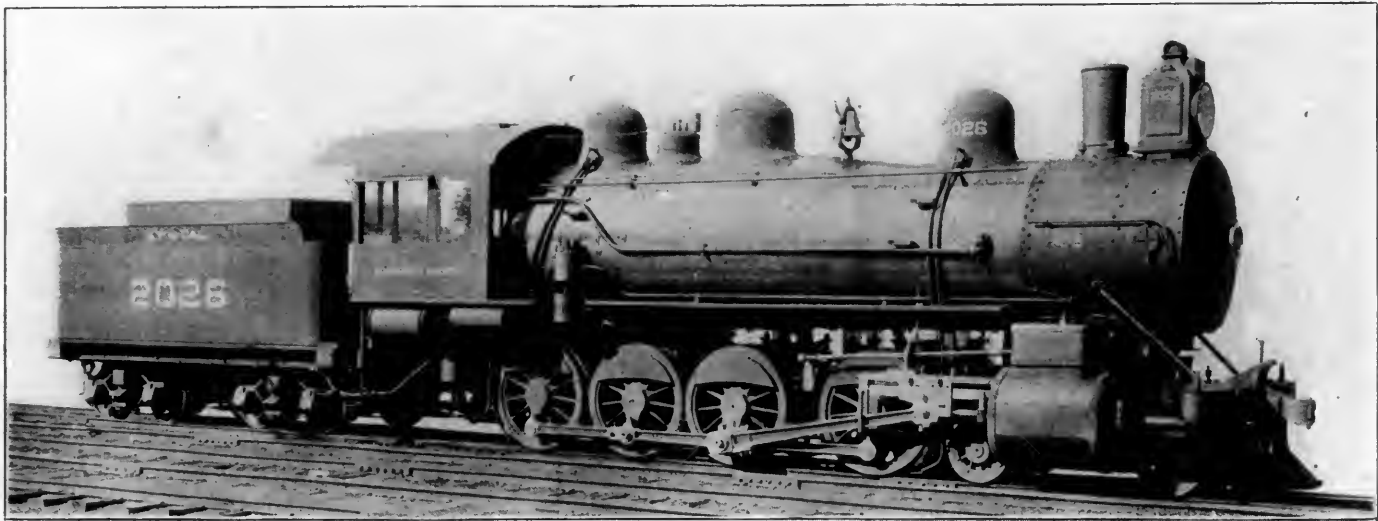
by each individual tool must earn its proportion of the expense of operating the plant, and that in this expense will be included its own repairs. In addition to this, it must earn on its output its particular proportion of the profit. We know of no fixed rule which can be applied to determine the amount of floor space required for a given amount of equipment. In the case of the machine shop, it will be found that for each machine the floor space required for operator, proper handling of work, etc., at that particular machine, will be very closely equal to twice the area occupied by the machine itself, the dimensions for determining the area occupied by the machine being equal to the product of its two extreme dimensions, and that the amount of floor space required in aisle room and general passageway will be approximately equal to 25 per cent. more than the space occupied by the machine. These figures do not allow for extensions or additional machines, but are intended only to include the original installation, placed as closely together as will be consistent with safety to the operator and handling of material.

In the case of the boiler shop these figures will not hold

MASTODON COMPOUND LOCOMOTIVES, SOUTHERN PACIFIC RAILWAY.

The heaviest two-cylinder compound locomotive of which we have record up to this time is the mastodon or 12-wheel type built by the Schenectady Locomotive Works for the Northern Pacific and illustrated in our issue of March, 1897, page 97. The same builders have completed ten of the same type, but larger and more powerful, for the Southern Pacific, one of which is illustrated by the accompanying engraving.

Comparison of the dimensions and weights shows that the Southern Pacific design is 12,000 pounds heavier in weight in working order and 5,000 pounds heavier on drivers. The cylinder power is greater, the cylinders of the Northern Pacific being 23 and 34 by 30 inches and of the Southern Pacific 23 and 35 by 32 inches. The low pressure cylinder is one inch larger



Schenectady Mastodon Compound.—Southern Pacific Railway.

good to the same extent, owing to the fact that the material handled at machines is frequently from three to four times the area of the space occupied by the machine itself, and it is also true that in this shop fully 75 per cent. of the floor space must be left free for the general handling of material and erecting.

In the blacksmith shop the conditions are in very many respects similar to those in the boiler shops, excepting in the matter of waste floor space. There being no erecting in this shop, the greatest amount of space is required around the tools where work is being done, and we would suggest an allowance of floor space for general handling of material equal to 50 per cent. in excess of the space occupied by the tools and that required for handling the parts in process of manufacture at these tools.

MECHANICAL STOKERS FOR MARINE BOILERS.

The mechanical stoker, in stationary practice, has been brought to a point justifying reference to it as an economical and efficient device. While there appear to be good reasons for experimenting with it in the field of marine engineering, we think that the first application of this kind to be made is that of the "American Stoker" in connection with Babcock & Wilcox boilers on a ship of the Zenith Transit Line, running between Cleveland and Duluth, on the Great Lakes. This form of stoker employs a screw conveyor, driven by a small motor, and the coal that is placed in a hopper at the furnace front is carried into the furnace and to the top of the fire along the length of the furnace. The coal slides down and spreads upon the grates, and as it passes up into the furnace it is heated and, giving off gas, it becomes coke before reaching the grates. The gases are burned as they are given off, and this, the coking and the agitation of the fuel in its delivery combine to give satisfactory combustion. If successful, this experiment may lead to further use of stokers in this service. The conditions which obtain in the fire rooms of ships need the improvement that automatic stokers can give, providing they can do the work without breaking down or requiring too much attention and outlay for repairs.

and the stroke is two inches longer. These, by the way, are the cylinder proportions of the Baldwin two cylinder consolidation compound of the Norfolk & Western, illustrated in June, 1898, page 181. The heating surface of the Southern Pacific engine is 3025.85 square feet, which is somewhat larger than the other, while the grate area is the same. The following table gives the principal dimensions of the new engine:

General Dimensions.	
Gauge	4 ft. 8½ in.
Fuel	Bituminous coal
Weight in working order.....	192,000 lbs.
on drivers.....	155,000 lbs.
Wheel base, driving.....	15 ft. 6 in.
" " rigid	15 ft. 6 in.
" " total	28 ft. 5 in.
Cylinders.	
Diameter of cylinders.....	23 and 35 in.
Stroke of piston.....	32 in.
Horizontal thickness of piston.....	5¼ and 4¾ in.
Diameter of piston rod.....	3¾ in.
Kind of piston packing.....	Cast iron rings
Size of steam ports.....	H. P., 20 by 2½ in. L. P., 23 by 2½ in.
" exhaust	H. P., 20 by 3 in. L. P., 23 by 3 in.
" " bridges	1½ in.
Valves.	
Lead of slide valves.....	Allen balanced
Greatest travel of slide valves.....	6½ in.
Outside lap of slide valves.....	H. P., 1¼ in. L. P., 1½ in.
Inside lap of slide valves.....	Clearance, H. P., ¼ in. L. P., ¼ in.
Wheels, etc.	
Diameter of driving wheels outside of tire.....	55 in.
Material of driving wheels centers.....	Cast steel
Driving box material..Main, cast steel. Intermediate, F. & B. steel	cast iron
Diam. and length of driving journals.....	9 in. dia. on main only
" " " " main crank pin journals main side, 7 by 5¼ in.	8½ in. dia. by 10 in.
" " " " side rod crank pin journals.....	6½ in. dia. by 6 in.
.....Inter., 5½ by 5 in. Front and back, 5 in. dia. by 3¾ in.	
Engine truck, kind.....	4-wheel swing bolster
" journals	6 in. dia. by 10 in.
Diameter of engine truck wheels.....	28 in.
Kind of engine truck wheels.....	Krupp, cast iron spoke center
Boiler.	
Style	Extended wagon top

Outside diameter of first ring.....	72 in.
Working pressure.....	200 lbs.
Material of barrel and outside of fire box.....	Carnegie steel
Thickness of plates in barrel and outside of fire box.....	11-16, 13-16, 1/2, 9-16 and 3/4 in.
Fire box, length.....	120 3-16 in.
" " width.....	42 in.
" " depth.....	F. 77 in. B. 73 1/2 in.
" " material.....	Carnegie steel
" " plates, thickness. Sides, 5-16 in.; back, 5 16 in.; crown, 3/8 in.; tube sheet, 1/2 in.	
" " water space.....	Front, 4 1/2 in.; sides, 3 1/2 by 4 in.; back, 3 1/2 by 4 1/2 in.
" " crown staying.....	Radial stays 1 1/2 in. diam.
" " stay bolts.....	1 in. diam.
Tubes, number of.....	32
" " diameter.....	2 1/4 in.
" " length over tube sheets.....	14 ft. 6 in.
Fire brick, supported on.....	Studs
Heating surface, tubes.....	2819.34 sq. ft.
" " fire box.....	206.51 sq. ft.
" " total.....	3025.85 sq. ft.
Grate surface.....	35.0 sq. ft.
Ash pan style.....	Hopper, dampers front and back
Exhaust pipes.....	Single
" " nozzles.....	5 1/4, 5 1/2, 5 3/4 in. dia.
Smoke stack, inside diameter.....	16 in. near bottom, at top 18 in.
" " top above rail.....	14 ft. 11 in.
Boiler supplied by.....	Two injectors—Ohio No. 10 and Monitor No. 10
Tender.....	
Weight, empty.....	39,650 lbs.
Wheels, diameter.....	33 in.
Journals, diameter and length.....	5 in. dia. by 9 in.
Wheel base.....	15 ft. 1/4 in.
Tender frame.....	Channel iron
Water capacity.....	4,500 gals.
Coal capacity.....	10 tons
Total wheel base of engine and tender.....	53 ft. 6 1/2 in.
Engine equipped with Westinghouse-American brake on all drivers operated by air; Westinghouse air brake on tender and for train, 9 1/2-in. air pump. Franklin Monarch magnesia sectional lagging. Sweeney brake arrangement on low pressure cylinder. Le Chatelier water brake on low pressure cylinder.	

FEED WATER HEATERS FOR LOCOMOTIVES.

True economy in the operation of locomotives lies, to a certain extent, in economical use of fuel, but it is much more important that the maximum number of tons should be hauled over the road at the proper speed and this means that great power is a primary requisite. The limit of power of the locomotive lies in the boiler, and the most desirable improvements

it was the practice, for about 25 years, to wash out the boilers at each end of a run of 137 miles or the engines could not make a return trip. The flues would not last over a year and much trouble was had with leaky fireboxes. The use of a simple feed water heater made it possible to run one of these engines five months, making a mileage of 20,000 without washing and without foaming, liberal use being made of blow off cocks. Feed water heaters are in general use in stationary practice where their value as purifiers is recognized, and it is generally accepted that scale 1-16-inch thick means about 12 per cent. additional fuel. Besides this, boilers would be relieved of many destructive strains if fed with hot water, this would probably show in the life of stay bolts and fireboxes.

Simple calculations show the theoretical gains to be expected from heating the feed from 50 degrees F. to 200 degrees for a boiler pressure of 200 lbs. per square inch, to be between 12 and 13 per cent. From data taken in a large number of tests on fuel economizers in England and on the Continent of Europe it has been shown that a saving of from 1.2 to 1.4 per cent. may be expected for each 10 degrees that the feed water is heated. Tests showing as much as 22 per cent. gain have been reported, but only half of this is enough to warrant earnest efforts in investigating this subject. We believe that from 7 to 10 per cent. may be counted upon with safety.

The theoretical gain in per cent is:

$$100 (Q - q)$$

$$H - q$$

Where H=total heat in one pound of steam at boiler pressure, reckoned from freezing.

Q=heat of the liquid at final temperature of feed.

q=heat of the liquid at initial temperature of the feed.

It is interesting to observe that the results of practice are generally better than the theoretical calculations promise, which tends to show that investigation in this field has not been exhausted. Feed water heaters have been decried on account of the comparatively small number of heat units that they put into the water, but it is important to note that the heat units furnished in this way are most valuable ones. The gain appears in three ways: As heat recovered that would otherwise have gone to waste, in increased evaporation per pound of fuel on account of a decrease in the rate of combustion per square foot of grate area and in better circulation in

TEST OF FEED WATER HEATER, WABASH RY.

From	To	Distance.	Total time on road.	Actual running time.	Average speed in miles per hour.	Weight of train in tons.	Car mileage.	Ton mileage.	Pounds coal used.	Pounds coal used per car mile.	Pounds coal used per ton mile.	Gallons water used.	Gallons water evaporated per pound of coal.	Miles run per ton of coal.	Average temperature of water in tank.	Average boiler pressure.
Decatur.....	Brooklyn, L-Y, with.....	110	4-54	4-12	26.19	691	3,300	76,010	10,000	3.03	.131	6,468	.647	22	107	150
108.4	without.....	108.4	4-45	4-07	26.33	628.6	2,728.4	68,141.2	11,000	4.031	.161	6,461.4	.587	19.7	51	155
Brooklyn.....	Decatur, with.....	108.4	6-05	3-11	34.05	689.2	3,023.3	74,712.7	14,000	4.63	.187	8,019	.572	15.48	108	.....
108.4	without.....	108.4	5-24	3-48	28.52	684.9	2,863.2	74,212.4	13,000	4.54	.175	6,271	.482	16.67	51	155
Decatur.....	Brooklyn, with.....	108.4	6-20	4-51	22.35	677.12	2,955.3	73,403.6	13,000	4.39	.177	6,875	.528	16.67	103	.....
110	L-Y, without.....	110	5-2	4-03	27.16	616	3,089	67,760	13,000	4.22	.192	6,913	.534	16.92	52	152
Brooklyn, L-Y.....	Decatur, with.....	110	5-58	4-58	22.14	726	3,300	79,830	11,000	3.33	.137	7,194	.654	20	110	159
108.4	without.....	108.4	5-55	4-53	22.19	793.2	2,907	85,988.4	15,000	5.159	.174	8,936	.595	14.45	51	148
Decatur.....	Brooklyn, with.....	108.4	5-36	3-43	29.16	801.7	3,484.7	86,904.5	13,000	3.73	.149	7,150	.55	16.67	100	.....
108.4	without.....	108.4	5-32	4-50	22.42	767	3,252	83,142.8	13,000	3.997	.156	6,270	.482	16.67	61	156
Total, with.....			28 53	20 55	.....	3,585	16,063.3	390,890.8	61,000	.....	.....	35,706	.....	.....	.....	.....
Total, without.....			26 48	21 41	.....	3,489.7	14,830.6	379,274.8	65,000	.....	.....	34,881	.....	.....	.....	.....
Average, with.....			5 46	4 11	26.06	717	3,212.6	78,178.1	12,200	3.797	.1565	7,141	.5853	17.87	105.6	.....
Average, without.....			5 22	4 20	25.07	698	2,966.1	75,854.9	13,000	4.382	.1713	6,976	.5366	16.75	53.2	.....
Per cent., with.....										13.35	8.64		8.32	6.68		

are those that permit of increasing capacity without exceeding the limits of weight. The true function of a boiler is the one pertaining solely to the evaporation of water and making steam. If the other duties ordinarily performed by the boiler can be executed satisfactorily in another way the increase of boiler capacity is promising.

Besides evaporating water at an enormous rate locomotive boilers are called upon to separate the feed water from scale and to furnish a large amount of heat to raise the temperature of the feed water to the point of evaporation. A feed water heater that is not more trouble than it is worth would evidently offer greatly needed relief, because water may be both purified and heated in a heater.

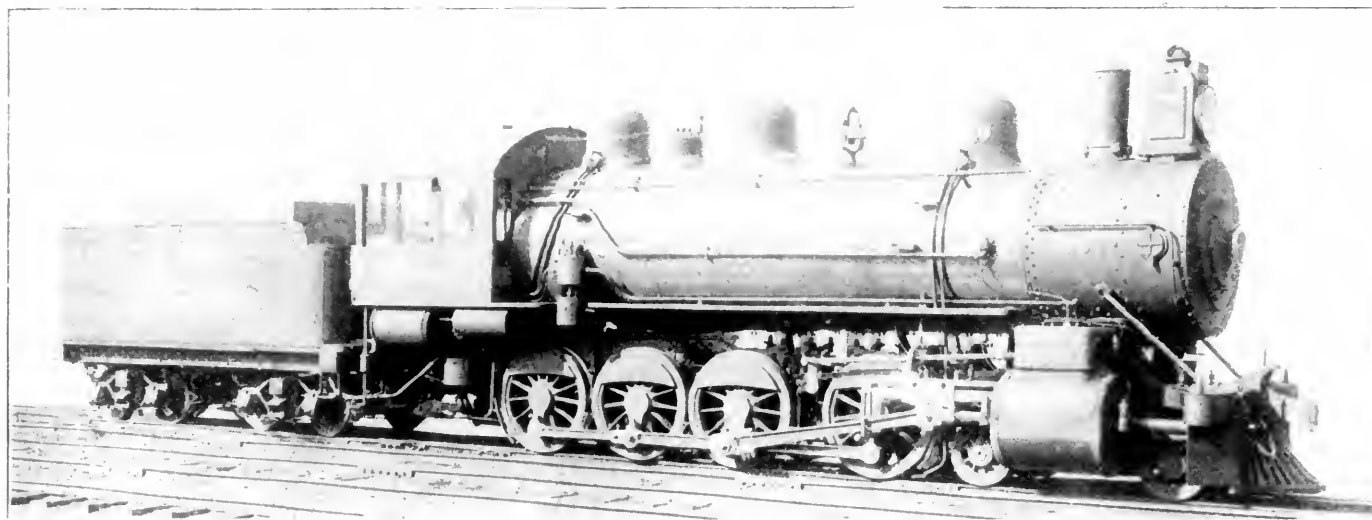
Records of the Union Pacific Railway show that before the application of feed water heaters on one of the worst divisions

the boiler, that is to say the heating surface is more efficient when it has to furnish the "latent heat" only. This last mentioned advantage is now attracting a great deal of attention in England, where feed water heating by live steam is reported upon the best of authority as giving as much as 15 per cent. increased economy. When Professor Unwin advocates such practice (as he does) there must be something in it in spite of the fact that it appears to be a case of "Robbe Peter and pay Paule." In Halpin's system of heat storage the boilers are fed with steam heated water and are said in consequence to be enabled to produce one-third more steam than if working direct from the mains. This means more power per pound weight of boiler, which is what we are seeking. There is evidently more to this subject than most people think.

In our issue of April, 1897, page 142, an illustrated descrip-

by each individual tool must earn its proportion of the expense of operating the plant, and that in this expense will be included its own repairs. In addition to this, it must earn on its output its particular proportion of the profit. We know of no fixed rule which can be applied to determine the amount of floor space required for a given amount of equipment. In the case of the machine shop, it will be found that for each machine the floor space required for operator, proper handling of work, etc., at that particular machine, will be very closely equal to twice the area occupied by the machine itself, the dimensions for determining the area occupied by the machine being equal to the product of its two extreme dimensions, and that the amount of floor space required in aisle room and general passageway will be approximately equal to 25 per cent. more than the space occupied by the machine. These figures do not allow for extensions or additional machines, but are intended only to include the original installation, placed as closely together as will be consistent with safety to the operator and handling of material.

In the case of the boiler shop these figures will not hold



Schenectady Mastodon Compound.—Southern Pacific Railway.

good to the same extent, owing to the fact that the material handled at machines is frequently from three to four times the area of the space occupied by the machine itself, and it is also true that in this shop fully 75 per cent. of the floor space must be left free for the general handling of material and erecting.

In the blacksmith shop the conditions are in very many respects similar to those in the boiler shops, excepting in the matter of waste floor space. There being no erecting in this shop, the greatest amount of space is required around the tools where work is being done, and we would suggest an allowance of floor space for general handling of material equal to 50 per cent. in excess of the space occupied by the tools and that required for handling the parts in process of manufacture at these tools.

MECHANICAL STOKERS FOR MARINE BOILERS.

The mechanical stoker, in stationary practice, has been brought to a point justifying reference to it as an economical and efficient device. While there appear to be good reasons for experimenting with it in the field of marine engineering, we think that the first application of this kind to be made is that of the "American Stoker" in connection with Babcock & Wilcox boilers on a ship of the Zenith Transit Line, running between Cleveland and Duluth, on the Great Lakes. This form of stoker employs a screw conveyor, driven by a small motor, and the coal that is placed in a hopper at the furnace front is carried into the furnace and to the top of the fire along the length of the furnace. The coal slides down and spreads upon the grates, and as it passes up into the furnace it is heated and, giving off gas, it becomes coke before reaching the grates. The gases are burned as they are given off, and this, the coking and the agitation of the fuel in its delivery combine to give satisfactory combustion. If successful, this experiment may lead to further use of stokers in this service. The conditions which obtain in the fire rooms of ships need the improvement that automatic stokers can give, providing they can do the work without breaking down or requiring too much attention and outlay for repairs.

MASTODON COMPOUND LOCOMOTIVES, SOUTHERN PACIFIC RAILWAY.

The heaviest two-cylinder compound locomotive of which we have record up to this time is the mastodon or 12-wheel type built by the Schenectady Locomotive Works for the Northern Pacific and illustrated in our issue of March, 1897, page 97. The same builders have completed ten of the same type, but larger and more powerful, for the Southern Pacific, one of which is illustrated by the accompanying engraving.

Comparison of the dimensions and weights shows that the Southern Pacific design is 12,000 pounds heavier in weight in working order and 5,000 pounds heavier on drivers. The cylinder power is greater, the cylinders of the Northern Pacific being 23 and 34 by 30 inches and of the Southern Pacific 23 and 35 by 32 inches. The low pressure cylinder is one inch larger

and the stroke is two inches longer. These, by the way, are the cylinder proportions of the Baldwin two cylinder consolidation compound of the Norfolk & Western, illustrated in June, 1898, page 181. The heating surface of the Southern Pacific engine is 3025.85 square feet, which is somewhat larger than the other, while the grate area is the same. The following table gives the principal dimensions of the new engine:

General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal
Weight in working order.....	192,000 lbs.
Weight on drivers.....	155,000 lbs.
Wheel base, driving.....	15 ft. 6 in.
" " rigid	15 ft. 6 in.
" " total	26 ft. 5 in.

Cylinders.

Diameter of cylinders.....	23 and 35 in.
Stroke of piston.....	32 in.
Horizontal thickness of piston.....	5¼ and 4¾ in.
Diameter of piston rod.....	3¼ in.
Kind of piston packing.....	Cast iron rings
Size of steam ports.....	H. P., 20 by 2¼ in. L. P., 23 by 2¼ in.
" exhaust	H. P., 20 by 3 in. L. P., 23 by 3 in.
" bridges	1½ in.

Valves.

Lead of slide valves.....	Allen balanced
Greatest travel of slide valves.....	6½ in.
Outside lap of slide valves.....	H. P., 1¼ in. L. P., 1½ in.
Inside lap of slide valves.....	Clearance, H. P., ¼ in. L. P., ¼ in.

Wheels, etc.

Diameter of driving wheels outside of tire.....	55 in.
Material of driving wheels centers.....	Cast steel
Driving box material.....	Main, cast steel. Intermediate, F. & B. steel. L. P., cast iron
Diam. and length of driving journals.....	9 in. dia. on main only
" " " " main crank pin journals main side, 7 by 5¼ in.	8½ in. dia. by 10 in.
" " " " side rod crank pin journals.....	6½ in. dia. by 6 in.
" " " " Inter., 5½ by 5 in. Front and back, 5 in. dia. by 3½ in.	
Engine truck, kind.....	4-wheel swing bolster
" journals.....	6 in. dia. by 10 in.
Diameter of engine truck wheels.....	28 in.
Kind of engine truck wheels.....	Krupp, cast iron spoke center

Boiler.

Style	Extended wagon top
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Outside diameter of first ring.....	72 in.
Working pressure.....	200 lbs.
Material of barrel and outside of fire box.....	Carnegie steel
Thickness of plates in barrel and outside of fire box.....	11-16, 13-16, 1/2, 9-16 and 3/4 in.
Fire box, length.....	1213-16 in.
" " width.....	42 in.
" " depth.....	77 in. 13, 73 1/2 in.
" " material.....	Carnegie steel
" " plates, thickness. Sides, 5-16 in.; back, 5-16 in.; crown, 3/4 in.; tube sheet, 1/2 in.	
" " water space.....	Front, 4 1/2 in.; sides, 3 1/2 by 4 in.; back, 3 1/2 by 4 1/2 in.
" " crown staying.....	Radial stays 1 1/2 in. diam.
" " stay bolts.....	1 in. diam.
Tubes, number of.....	32
" " diameter.....	2 1/2 in.
" " length over tube sheets.....	14 ft. 6 in.
Fire brick, supported on.....	Studs
Heating surface, tubes.....	2819.34 sq. ft.
" " fire box.....	26.51 sq. ft.
" " total.....	3025.85 sq. ft.
Grate surface.....	35.0 sq. ft.
Ash pan style.....	Hopper, dampers front and back
Exhaust pipes.....	Single
" " nozzles.....	5 1/2, 5 1/2, 5 1/2 in. dia.
Smoke stack, inside diameter.....	13 in. near bottom, at top 18 in.
" " top above rail.....	14 ft. 11 in.
Boiler supplied by.....	Two injectors—Ohio No. 10 and Monitor No. 10

Tender.

Weight, empty.....	39,650 lbs.
Wheels, diameter.....	33 in.
Journals, diameter and length.....	5 in. dia. by 9 in.
Wheel base.....	15 ft. 1/2 in.
Tender frame.....	Channel iron
Water capacity.....	1,500 gals.
Coal capacity.....	10 tons
Total wheel base of engine and tender.....	53 ft. 6 1/2 in.
Engine equipped with Westinghouse-American brake on all drivers operated by air; Westinghouse air brake on tender and for train, 9 1/2-in. air pump. Franklin Monarch magnesia sectional lagging. Sweeney brake arrangement on low pressure cylinder. Le Chatelier water brake on low pressure cylinder.	

FEED WATER HEATERS FOR LOCOMOTIVES.

True economy in the operation of locomotives lies, to a certain extent, in economical use of fuel, but it is much more important that the maximum number of tons should be hauled over the road at the proper speed and this means that great power is a primary requisite. The limit of power of the locomotive lies in the boiler, and the most desirable improvements

it was the practice, for about 25 years, to wash out the boilers at each end of a run of 137 miles or the engines could not make a return trip. The flues would not last over a year and much trouble was had with leaky fireboxes. The use of a simple feed water heater made it possible to run one of these engines five months, making a mileage of 20,000 without washing and without foaming, liberal use being made of blow off cocks. Feed water heaters are in general use in stationary practice where their value as purifiers is recognized, and it is generally accepted that scale 1-16-inch thick means about 12 per cent. additional fuel. Besides this, boilers would be relieved of many destructive strains if fed with hot water, this would probably show in the life of stay bolts and fireboxes.

Simple calculations show the theoretical gains to be expected from heating the feed from 50 degrees F. to 200 degrees for a boiler pressure of 200 lbs. per square inch, to be between 12 and 13 per cent. From data taken in a large number of tests on fuel economizers in England and on the Continent of Europe it has been shown that a saving of from 1.2 to 1.4 per cent. may be expected for each 10 degrees that the feed water is heated. Tests showing as much as 22 per cent. gain have been reported, but only half of this is enough to warrant earnest efforts in investigating this subject. We believe that from 7 to 10 per cent. may be counted upon with safety.

The theoretical gain in per cent is:

$$100 (Q - q)$$

H—q

Where H=total heat in one pound of steam at boiler pressure, reckoned from freezing.

Q=heat of the liquid at final temperature of feed.

q=heat of the liquid at initial temperature of the feed.

It is interesting to observe that the results of practice are generally better than the theoretical calculations promise, which tends to show that investigation in this field has not been exhausted. Feed water heaters have been decried on account of the comparatively small number of heat units that they put into the water, but it is important to note that the heat units furnished in this way are most valuable ones. The gain appears in three ways: As heat recovered that would otherwise have gone to waste, in increased evaporation per pound of fuel on account of a decrease in the rate of combustion per square foot of grate area and in better circulation in

TEST OF FEED WATER HEATER, WABASH RY.

From	To	Distance.	Total time on road.	Actual running time.	Average speed in miles per hour.	Weight of train in tons.	Car mileage.	Ton mileage.	Pounds coal used.	Pounds coal used per car mile.	Pounds coal used per ton mile.	Gallons water used.	Gallons water evaporated per pound of coal.	Miles run per ton of coal.	Average temperature of water in tank.	Average boiler pressure.
Decatur.....	Brooklyn, L-Y, with.....	110	4-51	4-12	26.19	691	3,300	76,010	10,000	3.03	.131	6,168	.647	22	107	159
	without.....	108.4	4-45	4-07	26.33	628.6	2,728.4	68,141.2	11,000	4.031	.161	6,161.4	.587	19.7	51	155
Brooklyn.....	Decatur, with.....	108.4	6-45	3-11	31.05	689.2	3,023.3	74,712.7	11,000	4.031	.187	8,019	.572	15.45	108	.....
	without.....	108.4	5-24	3-48	28.52	684.9	2,833.2	74,212.4	13,000	4.51	.175	6,271	.482	16.67	51	155
Decatur.....	Brooklyn, with.....	108.4	3-20	4-51	22.35	677.12	2,935.3	73,403.6	13,000	4.39	.177	6,875	.528	16.67	103	.....
	L-Y, without.....	110	5-2	4-03	27.16	616	3,080	67,760	13,000	4.22	.192	6,943	.534	16.92	52	152
Brooklyn, L-Y.....	Decatur, with.....	110	5-58	4-58	22.11	726	3,300	79,850	11,000	3.73	.137	7,194	.505	20	110	159
	without.....	108.4	5-55	4-53	22.19	703.2	2,907	85,988.4	15,000	5.159	.174	8,396	.505	14.45	61	148
Decatur.....	Brooklyn, with.....	108.4	5-35	3-43	29.16	801.7	3,184.7	86,904.5	13,000	3.73	.149	7,150	.55	16.67	100	.....
	without.....	108.4	5-32	4-50	22.42	707	3,252	83,142.8	13,000	3.997	.156	6,270	.482	16.67	61	156
Total, with.....			28.53	20.55	.....	3,585	16,063.3	390,890.8	61,000	.....	.....	35,706	.....	.....	.....	.....
Total, without.....			26.48	21.41	.....	3,189.7	11,830.6	379,271.8	63,000	.....	.....	31,881	.....	.....	.....	.....
Average, with.....			5.46	4.11	26.06	717	3,212.6	78,178.1	12,200	3.797	.1565	7,141	.5853	17.87	105.6	.....
Average, without.....			5.22	4.20	25.07	688	2,996.1	75,854.9	13,000	4.382	.1713	6,376	.5396	16.75	53.2	.....
Per cent., with.....										13.35	8.61		8.32	6.68		

are those that permit of increasing capacity without exceeding the limits of weight. The true function of a boiler is the one pertaining solely to the evaporation of water and making steam. If the other duties ordinarily performed by the boiler can be executed satisfactorily in another way the increase of boiler capacity is promising.

Besides evaporating water at an enormous rate locomotive boilers are called upon to separate the feed water from scale and to furnish a large amount of heat to raise the temperature of the feed water to the point of evaporation. A feed water heater that is not more trouble than it is worth would evidently offer greatly needed relief, because water may be both purified and heated in a heater.

Records of the Union Pacific Railway show that before the application of feed water heaters on one of the worst divisions

the boiler, that is to say the heating surface is more efficient when it has to furnish the "latent heat" only. This last mentioned advantage is now attracting a great deal of attention in England, where feed water heating by live steam is reported upon the best of authority as giving as much as 15 per cent. increased economy. When Professor Unwin advocates such practice (as he does) there must be something in it in spite of the fact that it appears to be a case of "Robbe Peter and pay Paule." In Halpin's system of heat storage the boilers are fed with steam heated water and are said in consequence to be enabled to produce one-third more steam than if working direct from the mains. This means more power per pound weight of boiler, which is what we are seeking. There is evidently more to this subject than most people think.

In our issue of April, 1897, page 142, an illustrated descrip-

tion of the Barnes feed water heater was printed. This and the Rushforth heater are probably the best known in connection with locomotives, although others have been successfully tried. On some roads it has for a long time been customary to provide means for blowing back the exhaust of the air brake pump, and years ago attachments were made to the pop valves whereby the escaping steam was carried into the water of the tender tank. These, with Strong's heater, applied to engines on the Chicago & Alton Railroad several years ago, and those applied by Mr. E. M. Herr on the Northern Pacific, which are referred to elsewhere, constitute the most important work that has been done in this direction, but more is likely to be done in the near future.

The heater which uses the exhaust steam from the air brake pump to warm the whole of the feed water in the tender tank is undoubtedly the simplest and easiest to apply and to use. It has been objected to on account of blistering the tank varnish, but other finish may be used; the only valid criticisms on this plan are that there is loss of heat through the large surface of the tank, and owing to the variable amount of water the temperature also will vary considerably. The tank may be lagged, if it is found to be worth while to do so, and as long as the temperature is below the point at which injectors refuse to work the variable temperature does not appear to be troublesome. Mr. J. B. Barnes, Superintendent of Motive Power and Machinery, inventor of the tank heater referred to, has kindly furnished a report from which the accompanying table was prepared, showing the results obtained by using the heater on five trips on engine No. 480 of that road in April, 1897. Five trips were made with the heater in use and five without it, the percentages of saving being indicated in the table.

Closed heaters have been tried in the smoke box and also on the tender, but there appears to be good reason to prefer heating by steam to relying upon the hot gases of the smoke box.

If a closed heater can be made small enough to be carried conveniently on the engine or tender without adding to the troubles of the enginemen and yet large enough to efficiently heat the water, it will undoubtedly pay to try it in service to heat the water to or near the boiling point and force it into the boiler by a steam pump. The exhaust of the air brake and feed pumps and possibly a small portion of the main exhaust of the engine could also be utilized for heating purposes. The heater should be also a water purifier and should be arranged to be easily cleaned from the sediment that now becomes scale and bakes on to the boiler heating surfaces. It would not adhere so closely to the heater surfaces and would wash off. It should be cheap to build and to maintain. The heater must be accessible, and it must be arranged so as to be instantly cut out of the circuit if it fails in any way, and must not then interfere with the ordinary method of handling the feed water. These conditions are severe, but if they can be met we believe that feed water heaters will come into general use. They are worthy of more attention than they have ever received at the hands of locomotive people.

A feed water heater adds something to the equipment of the locomotive, it weighs something of itself and it may require a little attention but the compensating advantages are: Increased boiler power per pound weight, a saving in the amount of coal and water to be carried, a saving of work for the fire to do and consequently there is less wasteful forcing of the fire. The best of these points is the increase in the power of the locomotive. Exhaust steam from the air pump, of which there is about one-tenth of a pound per stroke, may be used and even live steam may be taken for this purpose, with the promise of equally good results as are found in stationary practice.

Some troubles have been experienced in feeding hot water with injectors, but these have been overcome up to temperatures of about 125 degrees. Mr. E. M. Herr recently made a statement in speaking about his form of tank heater before the Western Railway Club, which will be found on another page of this issue.

If on reading these paragraphs some one is led to suggest a study of the application of feed heaters to locomotives the object for which they were written will be attained.

PNEUMATIC HAMMERS FOR RIVETING.

On page 406 of our December, 1898, issue, we stated that the pneumatic tools used by the Chicago Ship Building Company and described in Mr. Babcock's interesting paper on pneumatic riveting in ship building were furnished by the Chicago Pneumatic Tool Company. Information has since been received showing that at the end of September, 1898, which was probably about the date that the paper was written, 17 hammers, now known as the "Q. & C.," and controlled by the Q. & C. Company, were in use by that firm. This shows that our previous statement was an error.

HEAVIER LOCOMOTIVES FOR THE LAKE SHORE.

The policy of the Lake Shore & Michigan Southern of spending a great deal of money in securing favorable grades and using light locomotives is of long standing, but a distinct departure is now made in an order for 45 locomotives that, compared with all except the monsters recently built for special service, must be considered heavy ones. This order was placed with the Brooks Locomotive Works, of Dunkirk, N. Y., and we give some of the particulars of the design in the following table, which indicate the divisions into 15 six-wheel switchers, 15 consolidation and 15 ten-wheel engines:

	Switchers.	Consolidation.	Ten Wheel.
Weight on drivers	128,000 lbs.	133,000 lbs.	118,000 lbs.
Total weight.....	128,000 lbs.	150,000 lbs.	150,000 lbs.
Cylinders.....	19 by 26 in.	20½ by 28 in.	19½ by 30 in.
Drivers, outside....	52 in.	56 in.	62 in.
Boiler, type.....	Straight.	Wagon top.	Wagon top.
Pressure.....	170 lbs.	180 lbs.	180 lbs.
Firebox.....	34½ by 80 in.	42 by 114 in.	42 by 114 in.
Tank capacity.....	3,500 gals.	5,000 gals.	5,000 gals.
Coal.....	5 tons.	8 tons.	8 tons.

The three types will have Westinghouse air brakes, steel axles, Heginbottom bell ringers, National hollow brake beams, Sargent brake shoes, Gould couplers, Monitor injectors, Leach's sanding device, Nathan lubricators, A. French Co.'s springs, Latrobe tires and cast steel driving wheel centers.

NEW YORK RAILROAD CLUB.

Mr. Angus Sinclair read a paper before this club at the December meeting, in which he briefly sketched the transition from the primitive methods of transportation in European countries to present practice, and compared current European practice with that in this country. The methods of smokeless combustion of coals in Great Britain formed an important factor that was worthy of being copied here. The practice of using cars that were a development of the omnibus, while inferior to American cars in many ways, was explained on a score of lightness. The author commended the treatment of employees on the Continent, which, while strict in discipline, allowed holidays without loss of pay, and also there was considerable freedom with regard to passes for the men and their families.

EDITORIAL ROOMS OF "LOCOMOTIVE ENGINEERING" DESTROYED BY FIRE.

The havoc wrought by a fire which destroys even a part of the papers and records of a periodical publication is not appreciated by those who have not experienced it, and our sympathies are extended to "Locomotive Engineering" for the irreparable loss by the burning out of the editorial rooms and everything in them. The energy of Mr. Sinclair and his associates, who now occupy offices at 95 Liberty street, New York, will doubtless be equal to the emergency, and the January issue will appear as if nothing unusual had occurred. We join in expressing appreciation of the difficulties and praise of the performance.

PERSONALS.

Mr. J. R. Grover has been appointed Master Mechanic of the Kansas City, Pittsburg & Gulf, with headquarters at Wichita, Kan., to succeed Mr. C. A. De Haven, promoted.

Mr. George L. Bradley, the present Vice-President and General Manager of the Lake Erie & Western Railroad, will, it is reported, succeed to the Presidency of that road, made vacant by the death of Calvin S. Brice.

Mr. Oscar Autz has been promoted from the position of General Foreman of the Lake Shore car department at Cleveland and has been succeeded by Mr. W. Snodgrass. Mr. Autz has been with the road about five years, having formerly been connected with the Pennsylvania. He has been a regular contributor to this journal and is an authority on car subjects.

PERSONALS.

Mr. Grinnell Burt has again been elected President of the Lehigh & Hudson. This is his 40th term.

Mr. W. R. McKeen, Jr., has been appointed Master Mechanic of the Union Pacific at North Platte, Neb.

Mr. W. B. Bates has been appointed Master Mechanic of the St. Louis, Iron Mountain & Southern, at Memphis, Tenn.

Mr. James Gray has been appointed Foreman of the shops of the St. Louis, Iron Mountain & Southern at Mer Rouge, La.

Mr. C. A. Coffee has been appointed Master Mechanic and Car Builder of the Oconee & Western, to succeed Mr. A. J. Mentor.

George F. Gardner, formerly Master Mechanic of the Columbus, Sandusky & Hocking, died Dec. 9 at Eldorado Springs, Mo., at the age of 58 years.

Mr. E. D. Jameson has been appointed Assistant Master Mechanic of the Western Division of the Grand Trunk, with office at Battle Creek, Mich.

Mr. W. H. Patton has been appointed Signal Engineer of the Grand Trunk, with headquarters at Toronto, Ont., to succeed Mr. P. F. Hodgson, resigned.

Mr. L. L. Dawson, Master Mechanic of the Illinois Central at Memphis, Tenn., has been transferred to McComb City, Miss., to succeed W. B. Baldwin, deceased.

Mr. William Murdock has been appointed Assistant Engineer of Maintenance of Way of the Toledo Division of the Pennsylvania Company, with headquarters at Toledo, O.

Mr. Edward H. Lee has been appointed Engineer and General Roadmaster for the Chicago & Western Indiana and the Belt Railway of Chicago, vice F. C. Doran, deceased.

Mr. F. M. Gilbert has been appointed Engineer of Tests of the Northern Pacific, with headquarters at St. Paul, Minn. He will also have charge of the electrical work of the road.

William T. Moore, formerly for many years Master Mechanic of the Pittsburg Division of the Pennsylvania Railroad, died at his home in Sewickley, Pa., Dec. 1, at the age of 74 years.

Mr. James H. Manning, the energetic and efficient Master Mechanic of the Union Pacific, at Omaha, has been transferred to Cheyenne, and will have entire charge of the shops there.

Mr. C. L. Mayne, General Superintendent of the Fitchburg Railroad, has resigned. He has been connected with this road for six years and was formerly Superintendent of the Chicago & Atlantic.

Mr. N. E. Clucas, who for several years has been foreman of the Atchison, Topeka & Santa Fe, at Pueblo, Colo., has been appointed master mechanic at La Junta, Colo., to succeed Mr. John Forster.

Mr. D. H. Nichols, Superintendent of the Pecos Valley & Northeastern, has been appointed General Manager to succeed Mr. E. O. Faulkner, resigned. His headquarters are at Eddy, New Mexico.

Mr. O. O. Winter, who for the past year has been Trainmaster of the Norfolk & Western, has been appointed General Manager of the Brainerd & Northern Minnesota, with headquarters at Brainerd, Minn.

Mr. E. Richards has resigned as trainmaster of the St. Louis Southwestern, at Pine Bluff, Ark., to accept the position of General Manager of the Louisiana & Arkansas, with headquarters at Stamps, Ark.

Mr. S. D. Hutchins, who has had charge of the instruction car of the Westinghouse Air Brake Company, has been appointed to succeed the late J. W. Shannon as representative of the company at Buffalo, N. Y.

Mr. J. T. Stafford, heretofore General Foreman of locomotive repairs of the St. Louis, Iron Mountain & Southern, at Baring Cross, Ark., has been appointed Assistant Master Mechanic, with headquarters at the same place.

Mr. Walter G. Berg has been appointed Engineer of Maintenance of Way of the Lehigh Valley, with office at South Bethlehem. He was formerly Assistant Engineer at Jersey City, and succeeds Mr. Richard Caffrey.

Mr. P. J. Harrigan, General Foreman of the Baltimore & Ohio shops at Connellsville, Pa., has been appointed Master Ohio shops of the middle division of that road, with headquarters at Cumberland, Md., to succeed Mr. D. C. Courtney, resigned.

Mr. H. Tandy has resigned as Assistant Superintendent of the Brooks Locomotive Works to become Superintendent of the Canadian Locomotive Works at Kingston, Ontario. Mr. Tandy's experience qualifies him to fill his new position admirably.

Mr. J. C. Gleason has been appointed Superintendent of the Cincinnati, Portsmouth & Virginia, and the heads of the mechanical and road departments are to report to him. He was formerly Superintendent of Transportation, a position that has been abolished.

Mr. C. J. Smith has resigned as General Manager of the Pacific Coast Company, operating the Columbia & Puget Sound, Pacific Coast, Seattle & Northern and Port Townsend Southern Railroads and the Pacific Coast Steamship Company. He has been General Manager of the Pacific Coast Company since 1890.

Mr. A. L. Whipple, railroad representative of the Boston Woven Hose and Rubber Company, has resigned to accept the position of Sales Agent for the E. T. Burrows Company of Portland, Me. Mr. Whipple is widely and very favorably known among prominent railroad men, and the Burrows Company has done well to secure his services.

Mr. E. E. Loomis, Superintendent of the Tioga division of the Erie Railroad, has been appointed General Superintendent of the New York, Susquehanna & Western and Wilkesbarre & Eastern, to succeed Mr. C. D. McKelvey, resigned. Mr. Loomis has been with the Erie since April, 1884, and has been Superintendent of the Tioga division since November, 1894.

John E. Wootten, the inventor of the firebox that bears his name, died in Philadelphia December 16, after a brief illness, at the age of 76 years. He was a native of Philadelphia and began railroad work as Mechanical Engineer of the Philadelphia & Reading in 1845. He was rapidly promoted and became General Manager, a position which he held until his retirement from railroad service in 1886.

Calvin S. Brice, ex-Senator and railroad financier, died at his home in New York Dec. 15. At the time of his death he was President of the Lake Erie & Western, President of the Cleveland, Akron & Columbus, and First Vice-President of the Duluth, South Shore & Atlantic. He was born in 1845 and began railroad work in 1870, and his earlier positions were in charge of the legal departments of several roads successively. Mr. Brice's last and largest plan was to build a railroad system in China.

J. Taylor Gause, President of the ship and car building firm, the Harlan & Hollingsworth Company of Wilmington, Delaware, died at his home in that city December 1. He was born in 1823, in Pennsylvania, and begun as an office boy in these works. He advanced steadily, until he became President in 1883. He held that position until his retirement, in 1896, and resumed the office after the resignation of Mr. Henry G. Morse a few months ago. He began his career as a shipbuilder about twenty-five years before the era of iron ships.

Mr. Willard A. Smith, President of the "Railway and Engineering Review," who was Chief of the Transportation Department of the Columbian Exposition in 1893, has been appointed by the United States government to take charge of the Department of Transportation and Civil Engineering of the American Exhibits of the Paris Exposition. His efficient organization of the transportation exhibits at Chicago will be remembered as an important part of the success of that exposition, and a more satisfactory appointment in connection with the Paris exposition could not be made.

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Fitchburg.—Mr. C. L. Mayne, General Superintendent, has tendered his resignation, to take effect Jan. 1, 1899.

Genesee & Wyoming Valley.—Mr. D. Hyman has been appointed Receiver, with headquarters at Retsof, N. Y.

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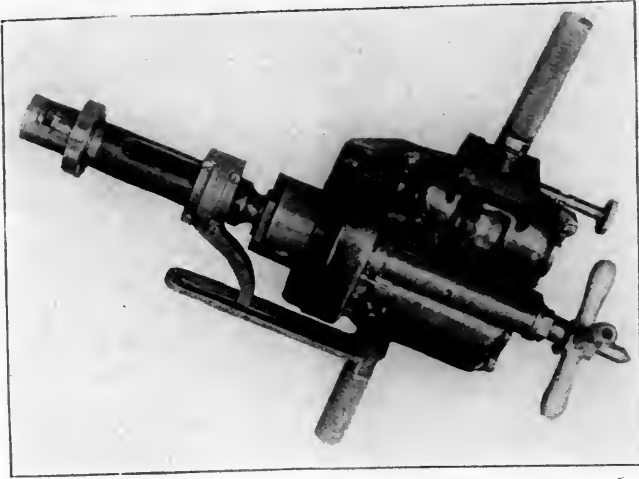


Fig. 1.

It is being introduced by the Chicago Pneumatic Tool Company in two sizes. Fig. 1 shows the No. 7 machine with a newly improved flue cutter attached, and Fig. 2 shows a No. 8 machine arranged for drilling. Both of the machines are reversible, and are regulated and governed by a throttle operated by a handle that is conveniently located. They have back gears and two speeds, and are surprisingly powerful considering their weight and compact size. The No. 7 drill complete weighs but 19 pounds and the No. 8 weighs 30 pounds.



Fig. 13.

The former is specially adapted to locomotive work, and the latter is exceedingly powerful and is intended for heavy boiler and shipyard work. It will drill holes as large as 2 inches in diameter in iron or steel, it will also roll flues that are 4 inches in diameter, and is especially well adapted for heavy tapping where a reversible motor is needed. The machines are fitted with screw feeding attachments for drilling, which

are replaced by breast plates when used in rolling flues. The throttle reversing and change gear devices are so arranged as to be very easily manipulated by the operator, and the whole plan of the machine is such as to permit of a large saving of time, labor and expense. It embodies the principle of "taking the machine to the work" instead of taking the work to the machine, and through the large amount of power provided the principle may be carried out to an extent not before attempted.

The machines will find their most extensive use in drilling and in rolling and cutting flues. In some experiments recently carried out at the "Nickel Plate" shops in Chicago it was demonstrated that with a No. 7 machine the cost of cutting out old flues and rolling in new ones may be reduced to 8 1-10 cents each, and when it is considered that a single boiler has from 200 to 350 flues it is clear that a large saving may be

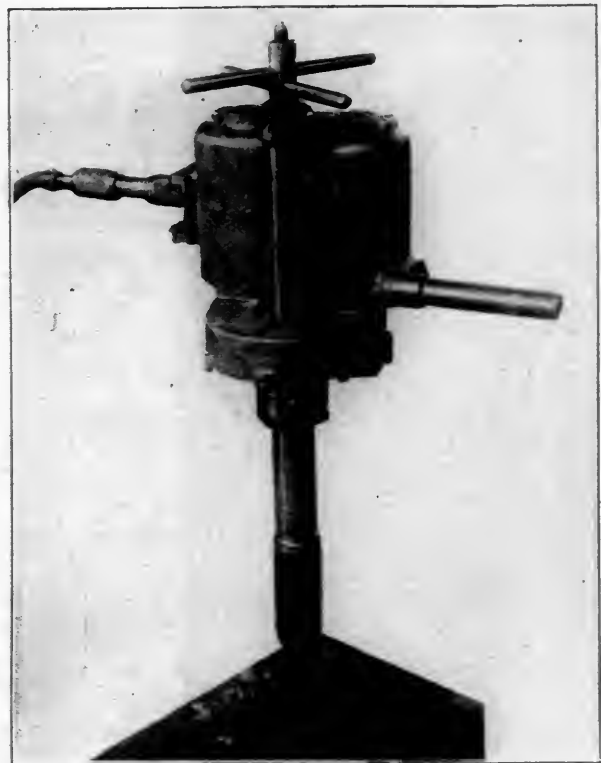


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Calvin S. Brice, ex-Senator and railroad financier, died at his home in New York Dec. 15. At the time of his death he was President of the Lake Erie & Western, President of the Cleveland, Akron & Columbus, and First Vice-President of the Duluth, South Shore & Atlantic. He was born in 1845 and began railroad work in 1870, and his earlier positions were in charge of the legal departments of several roads successively. Mr. Brice's last and largest plan was to build a railroad system in China.

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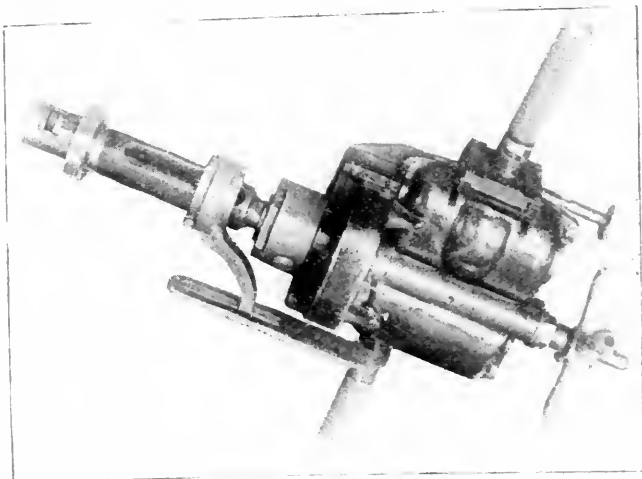


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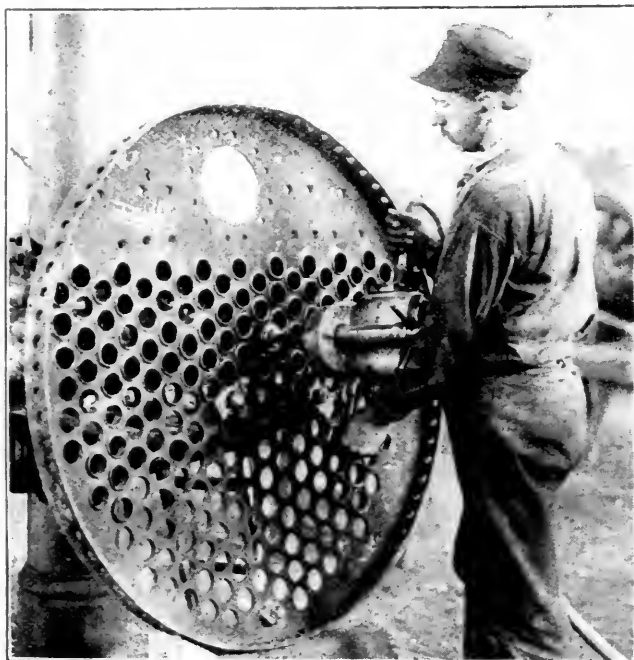


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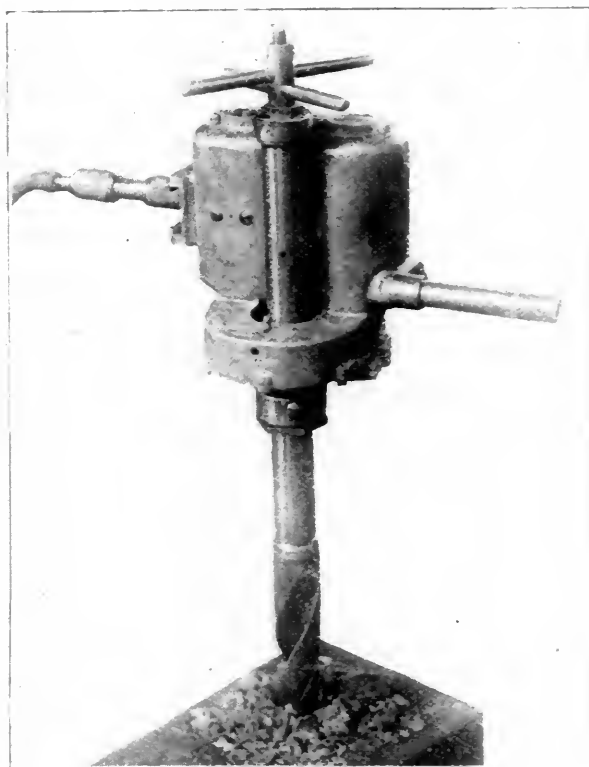


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the machine, and the uniformity of the work has resulted in an entire absence of trouble from leaky tubes. We are told that the men who operated the tools in these tests were unacquainted with them, and still better records may be expected. The machines, while light, are very strong and well made, and it is not to be understood that their usefulness is confined to the processes mentioned, for motors of this kind are adapted to a great many services in building and repairing machinery. A great many people have been looking for a satisfactory light motor, driven by air, and we believe this to be the best yet offered.

The principal offices for the Chicago Pneumatic Tool Company are Monadnock Building, Chicago, and 122 Liberty street, New York.

EQUIPMENT AND MANUFACTURING NOTES.

The Morse Twist Drill & Machine Company of New Bedford has bought out the T. & B. Company of Danbury, Conn., manufacturers of twist drills.

The Louisville & Nashville has fulfilled the provisional promise made some time ago to raise wages from the cut of 1893 to the former rates, the change taking place January 1.

The "Security Lock Bracket" furnished by the Chicago Grain Door Company is to be applied to 1,000 box cars for the Wisconsin Central, to be built by the Michigan Peninsular Car Company.

The Schoen Pressed Steel Company has recently received orders for steel cars of 100,000 pounds capacity from the Pittsburgh & Lake Erie, 500 cars; Lake Shore & Michigan Southern, 500 cars, and Baltimore & Ohio, 1,000 cars.

The syndicate headed by Joseph Leiter of Chicago has not only bought the Rhode Island Locomotive Works, but also the foreign rights in the Hoadley-Knight compressed air patents, and it is reported that the works will be entirely refitted.

Mr. Charles Hansel, Vice-President and General Manager of the National Switch and Signal Company, is to address the New York Railroad Club on the subject of Railroad Signaling at the regular meeting, January 19. A comprehensive and interesting presentation of the subject may be expected.

Contracts have been let for the extension of the plant of the Westinghouse Electric & Manufacturing Co. at East Pittsburgh. The extension includes the erection of shops and an office structure to cover four acres of ground. The proposed improvement involves the outlay of over \$200,000. The Carnegie Steel Co. will furnish all of the steel.

The Baldwin Locomotive Works have received an order for 10 locomotives from the Midland Railway of England. It is noted elsewhere that the Schenectady Locomotive Works have an order for a like number from the same road. These engines will have 18 by 24 in. cylinders, 62 in. driving wheels and will weigh, in working order, about 92,000 lbs.

An effort to secure uniformity in car sills will be made in connection with a committee report at the next Master Car Builders' convention. The circular issued by the committee requests information with regard to sills used for cars of 50,000 pounds capacity and over. There are good reasons for attempting to secure uniformity in this detail and, we believe, no objections.

The Pall Mall Gazette says that the Midland Railway Company has been compelled to order the construction of twenty freight locomotives in the United States, owing to the large number of advance orders held by the English locomotive works, and a dispatch from Schenectady states that the Schenectady Locomotive Works have an order for ten mogul engines, with 18 by 24 in. cylinders, for that road.

The consolidation of the Union and the National Switch and Signal companies was announced some time ago. At a meeting held in Pittsburgh Dec. 13 an issue of \$500,000 in 5 per cent. bonds was authorized, the number of directors was increased from five to seven, Messrs. Oakleigh Thorne and Robert Pitcairn being elected as additional members of the board. In the future there will be two vice-presidents, Mr. Thorne being the first and Mr. E. H. Goodman the second.

Mr. M. J. Martinez, member of the American Society of Mechanical Engineers, has received the appointment of resident agent at Havana, Cuba, for the Snow Steam Pump Works. He will be prepared to furnish pumps of the most modern designs made by the Snow Steam Pump Works, especially adapted for the requirements of the sugar industry in Cuba and Porto Rico. Mr. Martinez will conduct the business in his own name as consulting and contracting engineer.

The Babcock & Wilcox Company report the sale of 600 horse power of boilers to the Northern Pacific Railroad Company for supplying steam for power, heating and electric lighting for new shops at Brainard, Minn. They also report the sale of 500 horse-power Babcock & Wilcox boilers to the Boston & Maine Railroad, to be used in the electric power plant of the Portsmouth & Dover Railroad Company, which will be operated in connection with the Boston & Maine Railroad, using electric power.

Nearly all of the new freight equipment ordered by Receivers Cowen and Murray of the Baltimore & Ohio Railroad during the past few months, will be delivered by Jan. 15. The orders consisted of 3,000 standard box cars, from the Michigan Peninsular Car Company; 1,000 box and 1,000 gondolas from the Pullman Company; 2,000 box cars from the Missouri Car and Foundry Company; 1,000 steel coal cars of 100,000 pounds capacity from the Schoen Company, and five 50-foot modern mail cars from the Pullman Company. These cars are equipped with the Westinghouse air brake and M. C. B. automatic couplers.

The Joseph Dixon Crucible Company sends us a quotation from Mr. Wm. Hooper, of Ticonderoga, N. Y., called forth by the notice that has recently been given to the old sign in possession of the Western Society of Engineers at Chicago. The words "Harper's Ferry," painted in black, stand out as boldly as when they were first formed by the artist's brush, while the wood around the letters, which was painted with white paint, has worn away about one-sixteenth of an inch. Mr. Hooper says in part: "I have seen signs that have been painted with black paint directly on the clapboard of the building. The lettering was good after the paint on the balance of the building has disappeared, and after this the whole building was painted over, lettering and all, and the lettering obliterated; yet within ten years afterwards the old black lettering appeared again quite freshly to view. I suppose the paint for the lettering was made of linseed oil and lampblack. I believe, however, that finely ground graphite mixed with pure linseed oil, will last as long, or longer, than any other paint ever known of or used. I had a large iron casting which laid in my mill yard for over thirty years. It was painted with only one coat. The old casting was broken up and sold for old iron last month, and I noticed that the paint on the pieces of casting, even after being broken up, looked quite fresh. If the surface to be painted is perfectly dry when the finely ground graphite is applied, the paint will prove the most lasting paint known, because if time eliminates all of the oil, the graphite seems to adhere to the surface painted just the same as a piece of paper or wood will appear after it has been rubbed with a lead pencil or a piece of graphite. No other pigment known to me will remain on the surface painted after the oil has been thoroughly destroyed."

Mr. J. W. Duntley, President of the Chicago Pneumatic Tool Company, sailed for Europe since the appearance of our previous number, and will give his attention to the interests of the concern in Great Britain and on the Continent. The trip is made necessary by increasing foreign business, and we have reports showing that the demand for pneumatic tools in this country is larger than ever before. The facilities for manu-

facturing are employed to their full capacity to keep up with the increased demand on account of the present activity of the ship and navy yards, and the railroad orders are also greater than ever before.

American electric railroad equipment has received a substantial recognition for its good design and reliability in the form of an order for eight electric locomotives for the operation of the tunnel of the Paris-Orleans Railway, in Paris. This contract was secured in the face of the strongest European and British competition, the negotiations having covered two years. The transmission system will use three-phase generators and rotary converters, changing the alternating to a 500-volt direct current. The reason for the American success is stated to be superior experience and satisfactory examples of successful practice, the question of cost being virtually eliminated.

The Newport News Ship Building and Dry Dock Company is constructing a timber dry dock with concrete entrance. The clear length will be 806 ft., the breadth at the bottom 80 ft. and breadth at the top 162 ft. The depth over the sill is 30 ft. at mean high water, the range of the tide being 3 ft. The bottom will be of concrete, upon piling, and the interior of timber. The caisson will be of steel, with trimming tanks so arranged that it will not be necessary to pump out the water ballast. There will be two centrifugal pumps, driven by upright compound engines, that will pump out 200,000 gals. per minute and empty the dock in two hours. There is also a drainage pump, with 18-in. suction and discharge. The dock will accommodate the largest ocean liners or two first-class battleships.

The Manufacturers' Advertising Bureau, 126 Liberty street, New York City, turns the second decade of its existence with the close of the year 1898. Mr. Benj. R. Western, the original and present proprietor, established this unique business in 1879, and his success in the particular work he undertakes for his clients is widely recognized and taken advantage of by many of the representative manufacturers of the country. The bureau is a recognized authority on trade journal advertising, and handles the newspaper work and advertising of manufacturers using such publications so as to insure good results from the expenditure for such purposes. Its system furnishes a practical relief to its clients, and has brought the highest praise and commendation of conservative business men. The twenty years past have established the Manufacturers' Advertising Bureau as one of the solid institutions of the country, and copies of its booklet, "Advertising for Profit," may be had for the asking, by inclosing a business card.

The Railway Educational Association has been incorporated under the laws of New York with a capital of \$50,000, and its headquarters are at No. 1 Madison avenue, New York. The association was organized to conduct "The Railway Correspondence School" that was established in May, 1897, by Mr. George H. Baker, its purpose being the instruction of railway employees in the best methods for performing their duties. Instruction is given by means of printed lesson books, issued weekly by mail. These also contain examination questions which, when answered, are read by instructors of the school and used as means for further instruction. As directors the school has the indorsement of the following prominent railroad men: Mr. Paul Morton, Second Vice-President of the Atchison; Mr. Edwin Hawley, Assistant General Traffic Manager of the Southern Pacific, and President of the Minneapolis & St. Louis; Mr. George R. Brown, General Superintendent of the Fall Brook, and Mr. George H. Baker. Since its establishment the school has given two courses of instruction, one course for engineers to make them expert and economical in the performance of their work, and fit them for promotion to official positions in the mechanical department, and one course for firemen to likewise benefit them and fit them for promotion to the post of engineer. There are now on the railways in the United States about 74,000 engineers and firemen. Over 1 per cent. of this number, or 840, have joined "The Railway Correspondence School." The price of scholarship in the courses for engineers was \$18 in 1897, but is now \$20, payable in four monthly installments of \$5 each. The value of the instruction appeals to the men, and is appreciated by the officers, who find direct advantages from the improvement of their subordinates.

BOOKS AND PAMPHLETS.

Differential and Integral Calculus for Technical Schools and Colleges. By P. A. Lambert, M. A., Assistant Professor of Mathematics Lehigh University. New York: The Macmillan Company, 66 Fifth avenue, 1898, price \$1.50.

This is a book for students in technical schools and colleges, and according to the author's preface, its object is threefold. By a logical presentation of principles to inspire confidence in the methods of infinitesimal analysis, by numerous problems to aid in acquiring facility in applying these methods, and by applications to problems in physics, engineering and other branches of mathematics, to show the practical value of the calculus. The work is divided according to classes of functions, and the practical applications are introduced at the start with the object of at once engaging the interest of the student. Differentiation and integration are treated simultaneously and economy in time and effort is secured by the use of trigonometric substitution in simplifying integration. The idea of the author to show the connection between the calculus and practical work is an admirable one, which is well carried out as far as areas and volumes and radius of curvature are concerned, and he has attempted to depart from the too generally accepted idea among professors of mathematics that the subject should be taught for its own sake alone. This attempt is commendable, and should be encouraged, but we think it is not carried quite far enough.

Compressed Air Production, or the Theory and Practice of Air Compression. W. L. Saunders. Illustrated, 53 pages. Published by "Compressed Air," Havemeyer Building, New York, 1898, price \$1.00.

This is a compact work which admirably fulfils its title. Mr. Saunders is authority on air compression, and this concise treatment of the engineering principles of the subject will be welcomed by the many users of compressed air. A prominent feature of the book is the record of tests made by various authorities. A large number of different forms of air compressors are illustrated and the book contains a great deal of information that will be useful to those who use or contemplate using compressed air. The matter has appeared in the pages of "Compressed Air," but this form is a convenient one that will be appreciated. Moreover, we are informed that many of the numbers containing the original articles are now out of print, which makes the book more valuable. The treatment is complete, and not too technical for readers who are not well qualified to consider mathematical discussions.

"Catalogue of the Hopkins Railway Library." By Frederick J. Teggart, B. A., Librarian, Leland Stanford Junior University, Palo Alto, Cal. 231 pp. Price, \$1.50.

This catalogue undoubtedly gives the most complete list of books upon the subject of railways in existence. It is not a new publication, and has been reviewed in these pages before; occasion arises, however, for calling attention to it again. The Hopkins Railway Library, which is now a part of the library of the Stanford University, was built upon a collection of books upon the subject of railways started by Mr. Timothy Hopkins, of San Francisco, while treasurer of the Southern Pacific Company. In 1892 the collection, then numbering 2,000 volumes and pamphlets, was presented to the university, and provision made for its maintenance and increase. The collection has grown remarkably in the past few years, and it is now the most extensive and valuable collection on this important subject in the country. The publication of the catalogue makes the collection useful to those interested in the subject, and serves to direct attention to the value of a railway library, of which very few are available.

The classification of the catalogue includes bibliography, a list of periodicals and transactions, dictionaries relating to transportation subjects, fiction and verse, general books on railways, history and biography. The books on the railways of various countries and those on economics and law are next recorded, and the closing divisions of the subject are arranged as follows: Construction, equipment and operation, followed by a division devoted to local railways. At the end of the book is an index of the personal names which appear in the titles or notes throughout the catalogue.

On examining this book one is impressed with the variety of subjects covered and their importance. We are glad to direct attention to the extensive literature of railways and be-

lieve that interest should be stimulated in its collection and preservation.

Railway Engineering, Mechanical and Electrical. By J. W. C. Haldane, Civil and Mechanical Consulting Engineer. Illustrated with plates and engravings, 562 pages. New York, Spon & Chamberlain, 12 Cortlandt St. 1897. Price, \$6.00.

This book is very attractively bound and is well printed, with the important exception of many of the engravings. Its exterior appearance promises so much that the reader is disappointed upon the first glance at the pages. The subject is too large for a single volume, and yet the author finds space enough to present illustrated descriptions of a large number of machine tools, and we even find a large plate of a highway traction engine and another of a horizontal band sawing machine. These bear a certain distant relationship to railroad matters, but their appearance in a work by an engineer on "railway engineering" is hardly justified. The plain truth about the book, as we see it, is that a considerable amount of advertising matter has been included under a title which is somewhat misleading. The faults of the book are so manifest as to obscure the view of its good points. Readers may obtain information in regard to railroad shop practice, but at the cost of spending a lot of time on descriptions of machines for which they will not want to consult such a work.

The Metric System of Weights and Measures. Issued by the Hartford Steam Boiler Inspection and Insurance Co. Hartford, Conn., 1898. 196 pp., $3\frac{1}{2}$ by $5\frac{1}{4}$ inches; sheepskin. Price, \$1.25.

This convenient little book contains an elaborate set of tables for converting metric into English units and vice versa. Its object is thus stated in the preface: "The metric system of weights and measures is used so universally in foreign books and periodicals that much time is consumed and no little annoyance incurred by the American reader in translating these units into their English and American equivalents, by the aid of any of the reduction tables that have yet been published. It therefore occurred to the undersigned that a handy pocket volume for facilitating comparisons of this kind might be acceptable to engineers and scientific workers generally." In addition to tables of linear and surface measures, it includes weights, liquid measures, volumes, power and heat units. The tables include several that are not often used, and if these were omitted in order to lengthen the scope of the others, it would be an ideal collection.

A. D. Lectra's "Short Cut Calculation." Containing the Most Practical Methods of Calculation. Published by A. D. Lectra. West Superior, Wis. 140 pp. Cloth. Price, \$1.25.

The author's experience of many years as an expert accountant has given him a large number of short-cut methods of calculations, and checking accounts and process of figuring. Many of the methods will be found valuable even to those who do comparatively little calculating. The author gives many rules for the assistance of those who figure up freight charges and work of similar character. He does very well until he gives the "Average proportions of the various parts of locomotives," and informs the reader that the crank-pin should be one-fourth the diameter of the cylinder, valve stems should be one-tenth the diameter of the cylinder and that "wrought iron tires wear about one-twelfth of an inch per annum."

Annual Report of the Board of Regents Smithsonian Institution, showing Operations, Expenditures and Condition of the Institution to July, 1896. Government Printing Office, Washington, 1898.

The Purdue Exponent. Electrical Number.

The November, 1898, number of this wide awake college publication contains several articles that indicate the character of work done at this school. It begins with "Physics in Electrical Engineering," illustrating the facilities in electrical engineering, followed by a description of the dynamo laboratory. Other subjects are "The Uses of the Storage Battery in Railway Work," "Electrical Transportation," "The Commercial Aspects of Electrical Engineering," "The Training of An Electrical Engineer," "Wireless Telegraphy" and "Long-Distance Transmission of Power." This is the first of a series of special numbers on the departments of Purdue University.

Colonel Roosevelt's account of "The Rough Riders," which begins in the January Scribner's, although prepared in the heat of the campaign for the Governorship, shows no signs of hurry or fatigue. It is filled with humorous characteriza-

tions of the strangely assorted company of all types of Americans that went into the making of that unique regiment. The clear-cut idea which Colonel Roosevelt had in mind in getting up the regiment is revealed in this article and accounts in great measure for the successes achieved.

Baldwin Locomotive Works Record of Recent Construction, No. 9. December, 1898.

This pamphlet of 32 pages is uniform with its predecessors, and contains illustrations and the chief dimensions and characteristics of locomotives recently built by this concern. Fifteen designs of locomotives are shown, all but three of which are heavy, and three are of the Vaucrain compound type. Our readers are advised to secure these pamphlets as they appear, because they constitute a valuable record of American and foreign practice, as shown in the product of these extensive works.

The Watson-Stillman Company, of New York, has just issued a unique catalogue. It is at the same time a catalogue of the hydraulic tools and miscellaneous machinery manufactured by the firm, giving a small picture of each machine or tool, and an index to the complete catalogues that must be consulted for details and explanations. Mr. Stillman gives a great deal of attention to his catalogues, and his system is one of the best. This index presents the large variety of tools in condensed form and each engraving represents from one to about 20 sizes of tools, a complete illustrated description of each being given on a loose sheet, which may be called for by its number, and the sheet number is printed below the engraving in the index catalogue. These sheets are grouped in various combinations to suit the convenience of correspondents, and are neatly bound for the detail catalogues in the various lines or groups of machines or tools. This is necessary because of the immense variety of the product of the works, and the large number of interests to which the tools are necessary. It is impracticable to put the whole into a single volume. The continual production of new and improved appliances is another reason for using the loose plates. Those using hydraulic machinery of any kind will find this index useful as a guide to further correspondence. The engravings on these sheets are nearly all wood cuts, and are examples of clearness not often found in catalogues of any kind. They are the best that the engraver's art affords.

Pneumatic Tools, The Q. & C. Company. The valveless pneumatic tools formerly manufactured by the Ridgley & Johnson Tool Co., of Springfield, Ill., are illustrated and described in an admirable catalogue issued by the Q. & C. Company, who now control and manufacture them. These tools are used chiefly for riveting, chipping, caulking, beading flues, cutting stay bolts, chipping iron and steel castings, stone cutting and stone carving. The chief claim for these tools is simplicity. They are valveless, the working piston being its own valve, and they have but few parts. All tools of each size are made on the interchangeable plan, so that a part of one tool will fit all of the same size. The catalogue not only explains the tools themselves by aid of sectional drawings, but it gives the capacities of each size, and shows the character of work that they will do. The company announces its readiness to submit estimates upon complete pneumatic plants, including compressors. The catalogue gives information in regard to the selection of tools for different kinds of work, and will be found interesting and profitable reading by those who are using pneumatic tools for riveting, caulking or chipping. The catalogue contains a number of letters reproduced from the originals, giving the opinions of prominent railroad, ship-building and manufacturing officers upon the value of the tools, and it closes with illustrated descriptions of some of the shop tools manufactured by this company. We desire to compliment the Q. & C. Company for the excellent catalogue, its clear, concise statements, and unusually good engravings being specially worthy of mention.

LICENSES

To be sold in each district for Patent Safety Apparatus for Gauge Glasses adaptable for any kind of steam boiler. United States Patent No. 409,280. Greatest success in Europe under Government control and legalized introduction. First-class technical firms only are invited to correspond with HERREN: LEYMANNS & KIRM, Aix La Chapelle, Germany.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

FEBRUARY, 1899.

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THE DISCIPLINE AND EDUCATION OF RAILWAY EMPLOYEES.

By George R. Brown,

General Superintendent Fall Brook Railway.
Originator of the Brown System of Discipline.

An appeal to a man's better nature, to his self-respect, to his personal interests, to his loyalty to the interests of the company he serves—to make a practical application of the Golden Rule that would regulate the conduct of more than a million men—these constitute the spirit of the system of maintaining the discipline of railway employees known as "Discipline by Record and Without Suspension." This has in the last few years been adopted on fifty-three American railways, constituting over a third of the railway mileage in North America, and displaced the old system of maintaining discipline by suspending employees from service for considerable lengths of time, consigning them to enforced idleness and depriving them of the opportunity to earn the usual means for the support of themselves or families.

It must always be a source of great gratification to railway men that this appeal has been most satisfactorily responded to by the employees on every road and in every condition of service where it was inaugurated, equally so on large and small roads, and in the higher and lower grades of service.

Fear was entertained by many officers that the men subjected to the operations of the new and more humane system would consider the simple entry of an adverse record against them in a book as a very light matter compared with the severe and immediate punishment of a suspension, to which they were accustomed.

These fears proved groundless, and in every case it was quickly demonstrated that the employees were alive to the gravity of a standing adverse record against them, and they invariably tried harder to avoid such records than they had previously tried to avoid suspension. Each man realizing the fact that his daily service was making his record, good or bad, felt a greater responsibility in the proper performance of his duties, and in the performance of the duties of others who might by carelessness involve him in difficulty or subject him to censure. The result was an immediate and considerable improvement in the general efficiency and safety of the train ser-

vice, resulting on many roads in a noticeable annual decrease of 25 or more per cent. in the cost of accidents, and a larger comparative decrease in acts of negligence. A general superintendent reports that one effect of the record system is to rapidly weed out the incompetent and degenerates of all kinds, and it tends to retain the superior and thrifty men, who will be careful of their own lives and the lives and property entrusted to their care.

As a sequence of the employees who work under this system striving to make good records, it is noticed that the number of annual dismissals is reduced, on some roads to the extent of 34 per cent.; and that the frequency of the necessity of administering discipline is likewise greatly reduced. This all speaks for a more confident, contented and efficient working force, which on any road of considerable traffic must accomplish substantial economies in the costs of operation to keep pace with low rates and competition, if for no other purpose.

The record of an employee should not be a one-sided affair; the giving of judicious credits for specially meritorious service, and for long terms of perfectly satisfactory service, which shall balance possible demerit entries, is only just and wisely prudent. It is a commendable policy that encourages the building up of a good record, and encourages the attentive and careful performance of the daily duties which in the aggregate make large economies or large wastes.

It has come to be generally understood that the underlying principle of the system of discipline by record and bulletin is education—the kind of education that turns the occasional experience of individual employees to good account for the improvement of the whole service, by making such experiences object lessons for the proper and effective instruction of all employees, as well as those directly concerned. Thus, if any employee fails in some duty, and delay to traffic, damage to property or other loss to the company results, directly or indirectly, publication of the facts by bulletin serves to instruct all other employees on the road of the consequence of such failure, and effectively cautions them against similar lapses.

Used in this manner the bulletin board has proved to be a very valuable educator. Its lessons are simple and directly to the point, and partake of the impressiveness of generally costly and sometimes disastrous experience. In the course of the natural evolution of the education of railway employees it is quite probable that the bulletin board will become an auxiliary instead of a chief factor in the work. It is better to teach how not to err than to teach the consequences of erring. But when errors occur, even with the best system of instruction, their lessons must be pointed out, learned and heeded by all concerned. In no other kind of employment embracing large numbers of men does intelligence and education count for so much as in the railway service, and in no other kind of employment can the employees inflict greater losses to the interests they serve than a lack of intelligence and a thorough knowledge of their respective duties.

Large economical advantages will result when all railway managements arrive at a realizing sense of the great extent to which their employees affect the costs of operation, by the intelligence or ignorance and the carefulness or carelessness with which they perform their duties, while keeping within the letter of the rules.

Through the courtesy of the Secretary of the Interstate Commerce Commission I have been favored with advance data from the forthcoming report of the Commission for 1897, and am therefore able to submit statistics of railway operating expenses for the year ending June 30, 1897, herewith first published. These statistics show that approximately the sum of \$108,000,000 is annually expended for maintenance of track on the railways in the United States:

Cost of Maintenance of Track on Railways in the United States, 1897.

Repairs of roadway	\$73,711,471
Renewals of rails	10,703,304
Renewals of ties	23,245,161
Total	\$107,659,936

Education, stimulated by awards of premiums, has proved capable of effecting large savings in this work. Proper instruction in the best and most economical methods of track maintenance, the proper use and care of tools, the preservation of materials, etc., can save railway companies a considerable percentage of the present outlay for maintenance of track, besides assuring greater safety to trains and reduced cost of repairs to the rolling equipment. In recent years intelligently directed efforts to economize in locomotive supplies have achieved, mostly through reduced consumption of coal, such gratifying results as annual savings of \$112,000 on one road, \$250,000 on another, and \$300,000 on another.

These sums indicate the value to railway companies of the proper instruction of engineers and firemen. It has been proven that an engineer can on an average easily save or waste a ton or a ton and a half of coal a day in the operation of his engine. Firemen can also save or waste large quantities of coal. It would be greatly to the benefit of railway interests if all locomotive men could be thoroughly educated in the scientific principles underlying their work, and be thus brought to practice and to understand the advantages of the best methods. Consider the pitiable conditions attending the operation of a locomotive whereon the fireman, either through his own or his engineer's ignorance and carelessness, unnecessarily shovels into the firebox forty tons of coal a month, uselessly consuming valuable fuel and uselessly performing as much unpaid-for work as he would do in firing his engine five or six 100-mile trips. Many operating and mechanical officers can pick out instances of such work on their own roads, engines in the same service and in equally good condition burning 30 or 40 tons of coal per month more than others.

Such instances are sometimes noticed, and the more extravagant engineer is called to the office and warned that he must reduce the coal consumption of his engine to approximate that of the more economical engines. No inquiry may be made of him or his fireman to learn whether they understand and practice the best and most economical methods of firing, boiler-feeding and the use of steam; and yet upon such knowledge and practice must depend the quantity of coal their engine burns in hauling trains. Criticism or punishment administered by the wise looking official in charge without explaining how to produce better results is not what such men need. Their malady is ignorance, and its only effective and permanent cure is education. Both engineers and firemen should know, as thoroughly as they do the road they run over, every natural operation performed and influence brought into play during the process of generating heat by the combustion of coal and the conversion of its energy into the useful work of hauling trains through the medium of steam and their locomotives. The cycle of these operations can be clearly comprehended by any youth with sufficient intelligence to justify his employment as a locomotive fireman, and the liberal wages generally paid to engineers (average \$1,150 yearly) and firemen (average \$644 yearly) surely justify some reasonable requirements concerning intelligence, ability and economy of the most expensive operating supply, locomotive fuel. By the proper care or abuse of boilers, the proper or improper use of lubricating oils and the careless or careful handling of the air brake, locomotive engineers also further and largely affect the costs of operation and of the maintenance of both cars and locomotives.

The statistics before referred to show that the following amounts were expended in 1897 for the maintenance and operation of locomotives:

Costs of Maintenance and Operation of Locomotives in the United States, 1897.	
Fuel for locomotives.....	\$65,044,670
Water supply	4,683,124
Oil, tallow and waste.....	2,532,534
Other supplies	1,105,061
Repairs and renewals of locomotives.....	39,214,355
Total	\$112,644,744

Each of these large items of expense is capable of being reduced by such education of enginemen as has been outlined.

The annual aggregate of such reductions would surely reach far into the millions of dollars.

It is coming to be recognized by some officers that the education of railway employees should to some extent precede employment, and that it should be the self education of the applicant for a position in the railway service. In other words, an applicant for a railway position should be able to satisfy the employing officer of his fitness to assume the duties he desires to perform, by his possession of knowledge of the fundamental principles governing those duties. The present practice on most roads permits a green trainman to begin remunerative employment while practically ignorant of the rules and of nearly every duty he should intelligently perform, trusting that he will study the rules after being employed, and that practical experience and that gained from the older trainmen will teach him the proper performance of his duties. Also green firemen are permitted to enter the cab and be paid for actually burning up the money of the company through their unnecessary consumption of coal consequent on their total ignorance of the fundamental principles of combustion and of proper methods of firing. Considerable knowledge could easily be acquired by applicants for such positions regarding the duties of the same, that would enable them to more intelligently and quickly learn the proper practical performance of their work. After employment, neither the disposition or opportunity is so favorable to study as before.

The more careful education of train service employees is capable of improving their services in many ways, enhancing the safety and facilitating the movement of trains, inducing the more careful handling of cars, preservation of tools and use of supplies; inducing also the more considerate treatment of patrons, and the more intelligent use and care of air brake, heating, ventilating and illuminating appliances.

The same authority before quoted gives the following statistics:

Cost of Maintenance of Cars on Railways in the United States, 1897.	
Repairs and renewals of passenger cars.....	\$15,683,740
Repairs and renewals of freight cars.....	44,155,087
Repairs and renewals of work cars.....	971,618
Total	\$60,810,445

Proper charges for superintendence, repairs and renewals of shop machinery and tools, and other necessary expenses increase this amount to about \$70,000,000. Those who are practically familiar with the work of train service employees cannot doubt that a very considerable portion of this large outlay could be saved to railway companies by education that would enable and induce these men to exercise greater care and intelligence in the performance of their duties.

These illustrations are sufficient to show that the better education of railway employees promises substantial economies in the many items of expense that go to make up the costs of railway maintenance and operation. Every legitimate means to this end should receive practical encouragement from all who have the best interests of our railways at heart, and every effort of every employee toward self-education and the improvement of his services should be encouraged and rewarded.

As in the case of discipline by record it is found that the interests of railway companies and their employees are mutually benefited by the improved system, so likewise must it be with the better education of employees that will improve their minds and enhance the value of their services. While the companies which employ them will profit by the savings effected, the employees will grow in intelligence, advance in position and in the esteem of their officers, and surely better the condition of their employment and of their surroundings at home.

Ordinary steam pumps are proverbially wasteful, but the consumption of 700 pounds of steam per horse-power per hour by two pulsometers at the Lykens breaker, reported by Mr. R. Van A. Norris in a paper recently read before the American Society of Mechanical Engineers, is the highest attainment of which we have record.

BUILDING 15 FREIGHT CARS PER DAY.

Chicago, Milwaukee & St. Paul Railway.

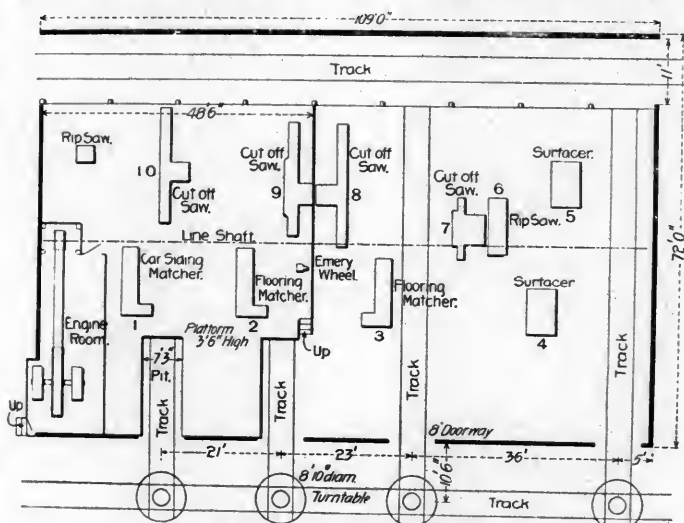
J. N. Barr, Superintendent Motive Power.

J. J. Hennessey, Master Car Builder.

The chief interest in the plant of the car department of the Chicago, Milwaukee & St. Paul Railway at West Milwaukee is that, while originally built for a repair shop, with a rearrangement of the machinery, a very few additions to the machinery and the building of an extension to the erecting shop, it is enabled to turn out 15 box cars of 60,000 lbs. capacity per day. The plan of a portion of the plant devoted to car work is reproduced in one of the engravings, showing the relative locations of the different buildings and the lumber yard. An output of 15 cars for each working day from the middle of January, 1898, until the 6th of June, then 10 each day until Sept. 1, and 15 again from Sept. 1 to Nov. 8, without a break in the record, is a most creditable performance, especially when it is considered that the usual repairs to passenger and freight

recesses in the elevated platform, which is 3 feet 6 inches high, and occupies the left hand half of the building. The light material is handled at this end of the shop, while the heavier stuff goes to the machines at the other end, where the floor is level with the tracks. All material goes across this shop and out at the other side, where it is loaded upon larger push cars, some of which are double-decked and are brought in on the longitudinal track. There are 15 men in this shop, and it is a busy place, where no material is allowed to be piled on the floor.

The large wood-working shop is 404 by 83 feet, with the machinery arranged as shown in the engraving. The idea upon which this mill is operated will be seen by following the course of large timbers, such as sills and plates, through it. These timbers come into the building upon track No. 1 at the upper right hand corner, they pass through the large sill dresser, indicated by "A," and the leading end of the timber is cut off square by saw No. 2, after which that end is tenoned by No. 3. The timber then passes in a direct line to the shop gage, where it stops at the right place to bring the rear end

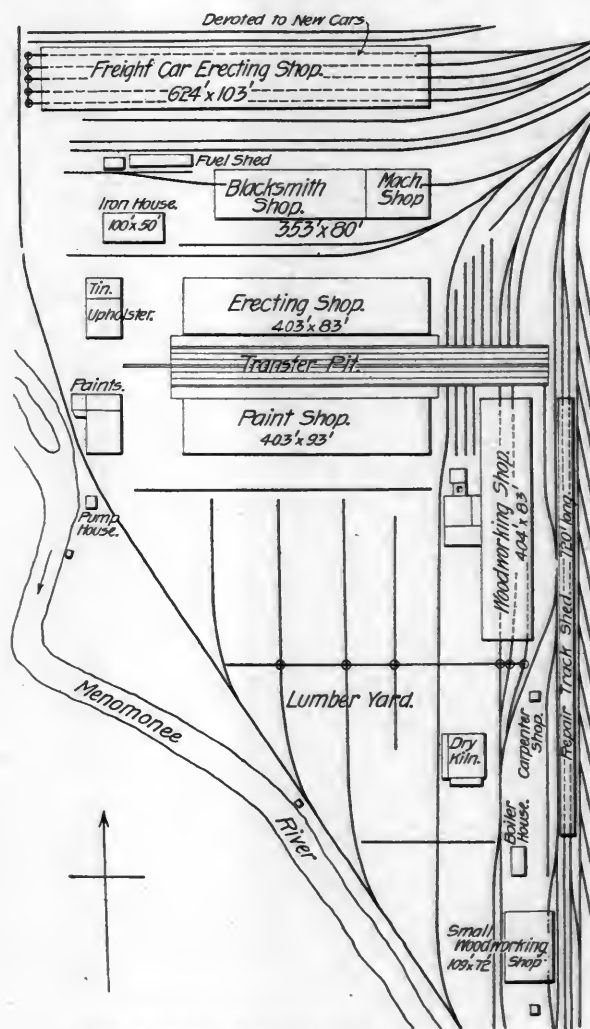


Small Wood Working Shop.

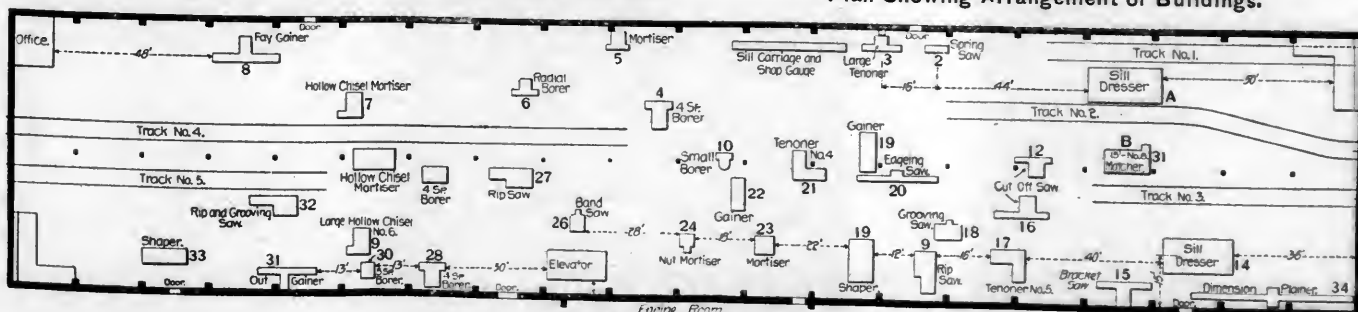
equipment have been carried on at the same time, together with an occasional order for special equipment, such as new cabooses. During the year 1898 3,800 freight cars were built here and placed in service. Of this number 500 were 50-foot carriage cars, illustrated on page 8 of our January issue, and 25 were refrigerator cars 36 feet long. The shops are now turning out 15 box cars per day, in accordance with the plan described below.

The underlying idea in the entire plan is to make every movement of material count in the construction of the cars, and to that end machinery and facilities have been arranged to avoid all unnecessary handling of material.

The small wood-working shop is used for manufacturing sheathing, flooring, siding and material for roofs and doors. The building is 109 feet by 72 feet. The material is brought in on four transverse tracks for push cars, entering the building from the side toward the lumber yard. Two of them extend entirely across the building, while the others run into



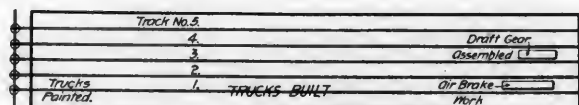
Plan Showing Arrangement of Buildings.



Large Wood Working Shop.

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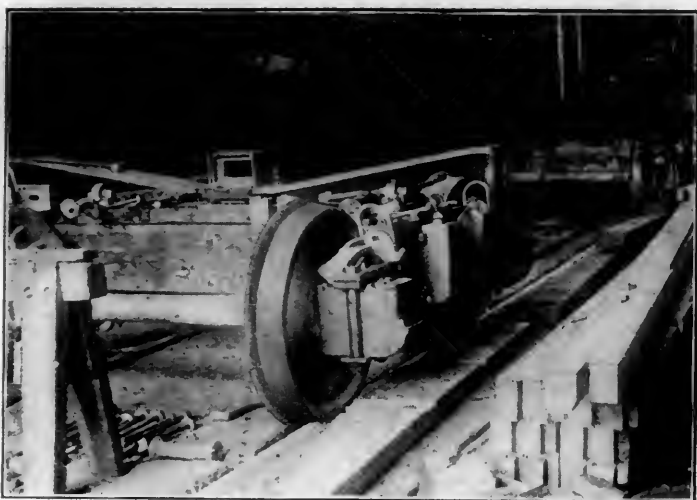


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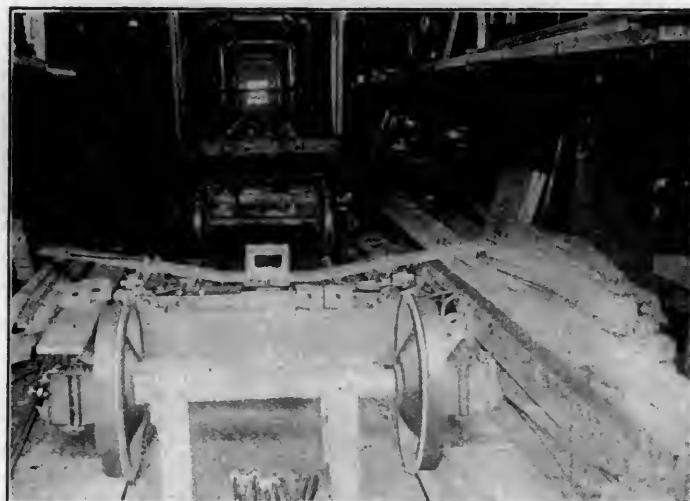


Fig. 2.

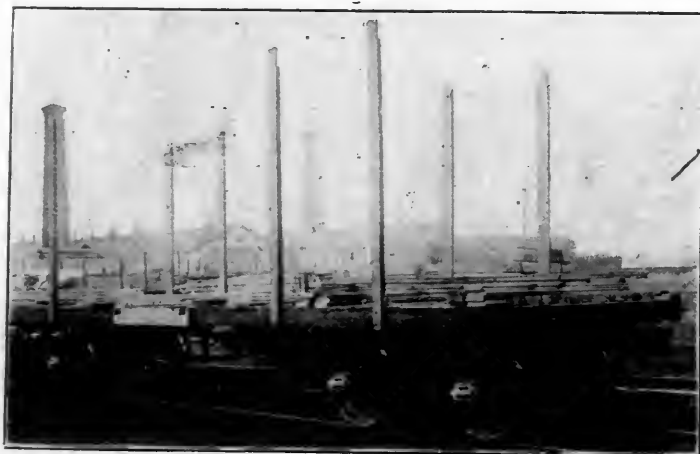


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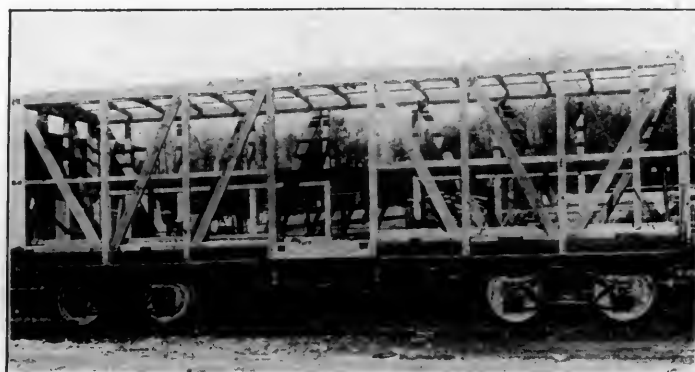


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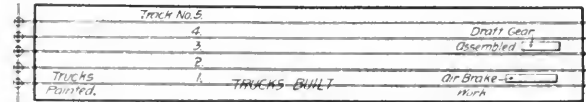
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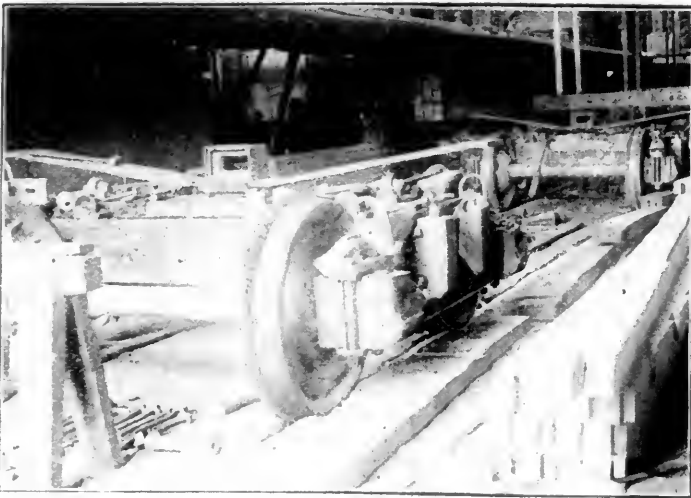


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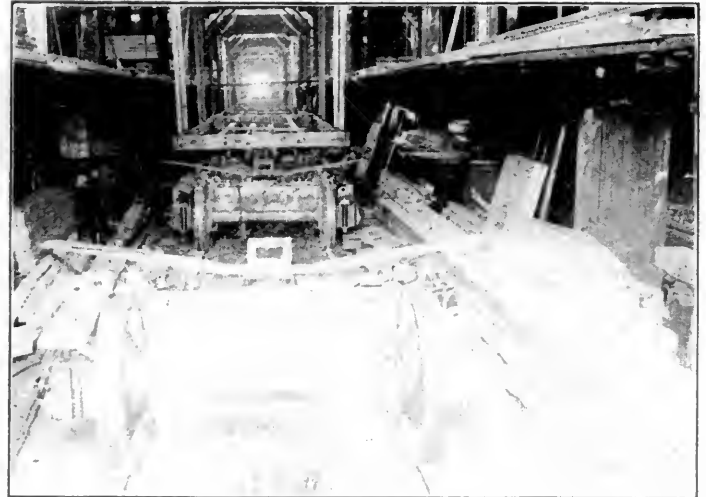


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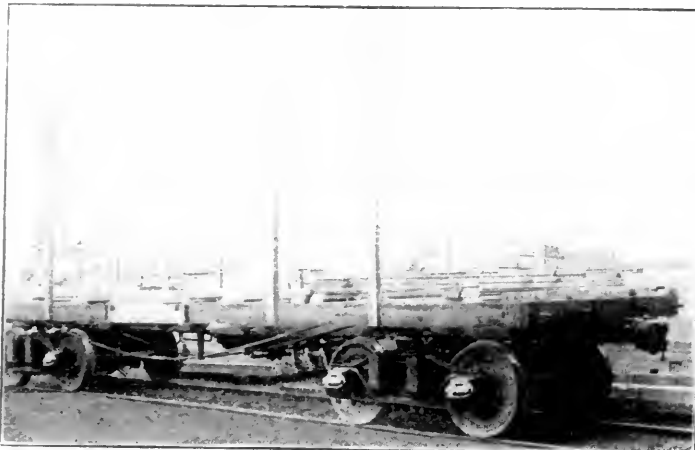


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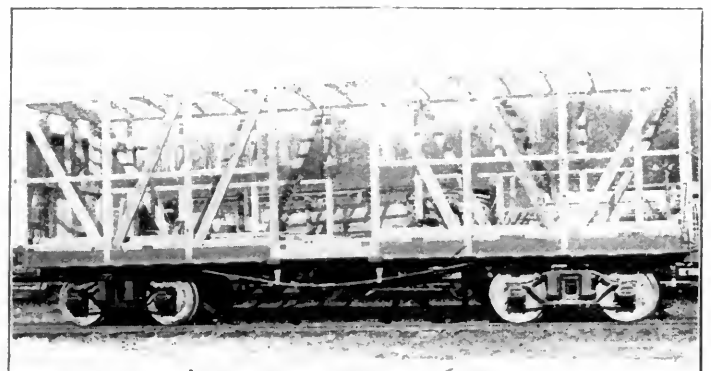


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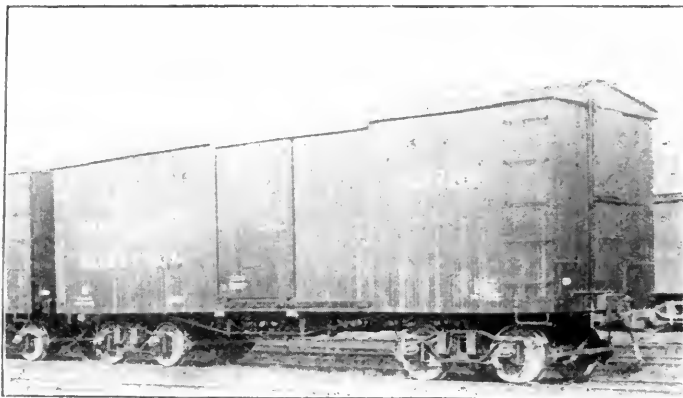


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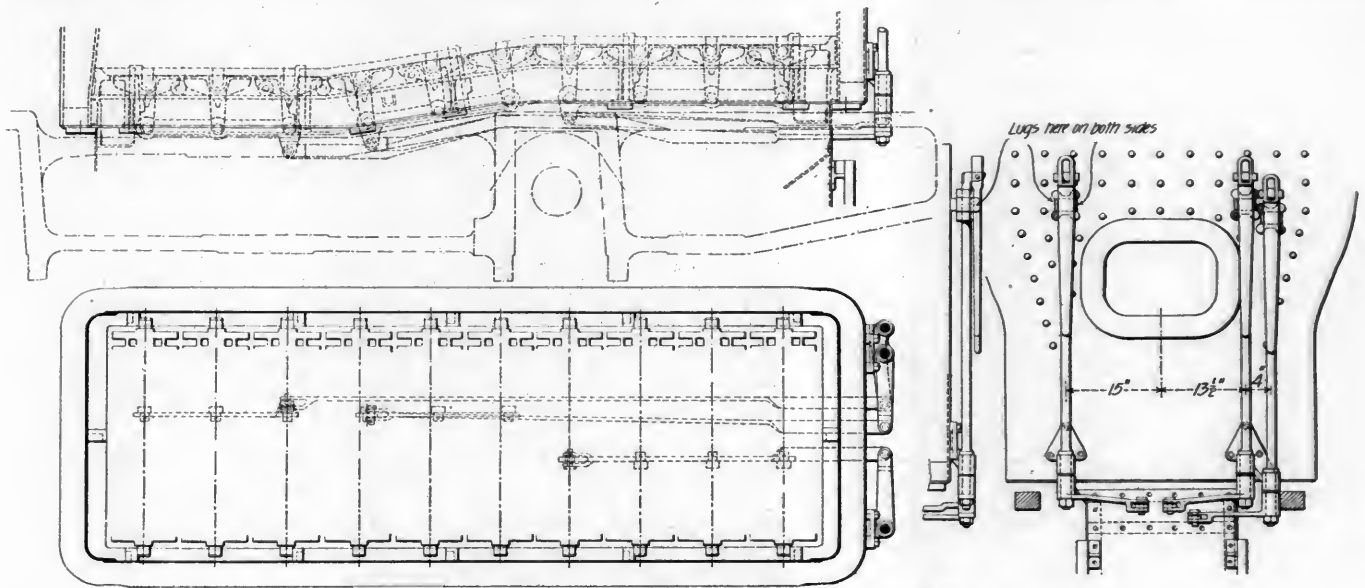
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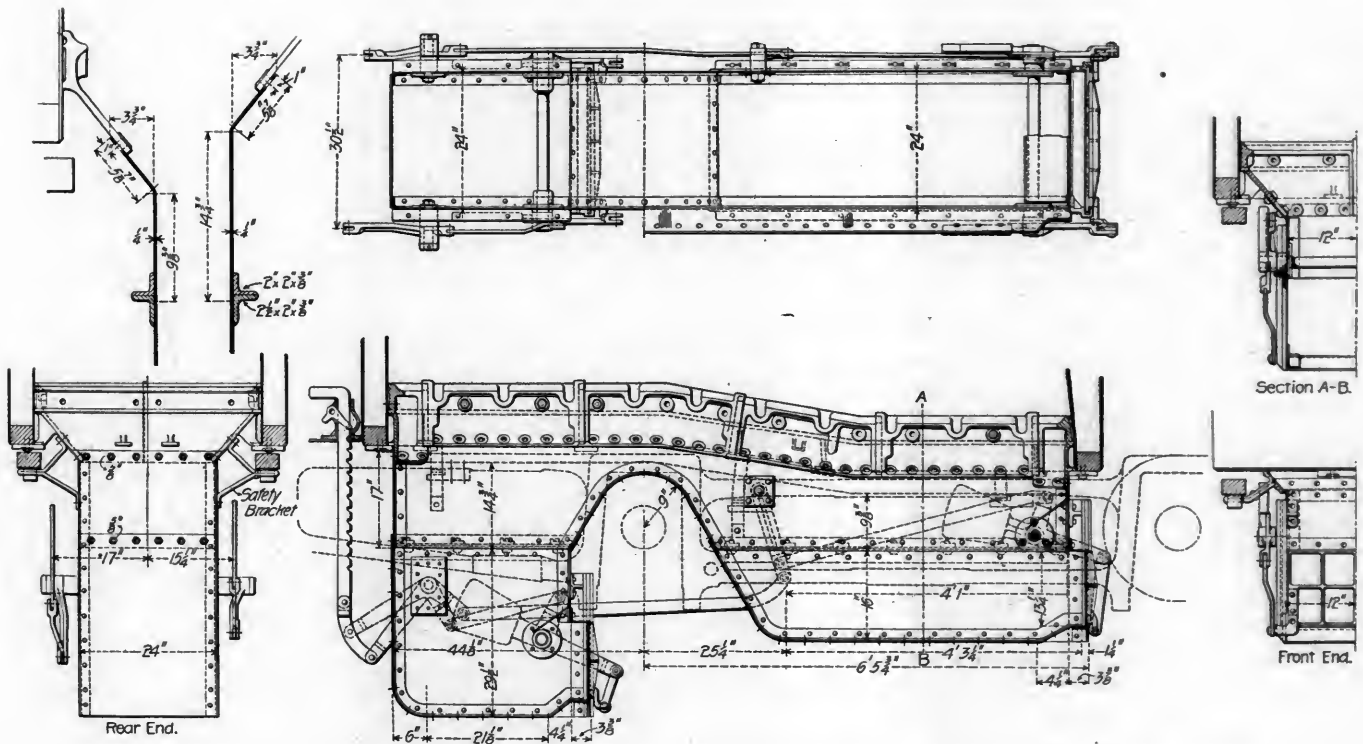
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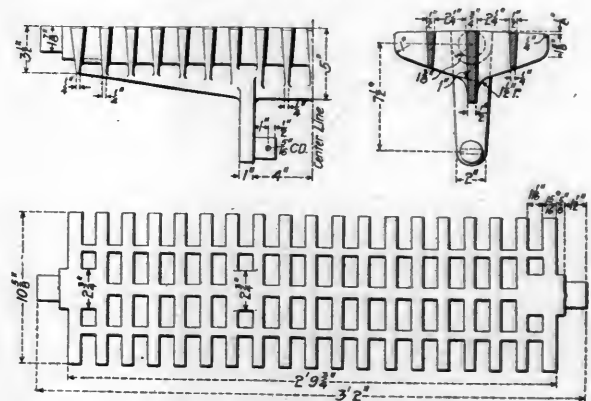


Shaking Grate for Anthracite Coal—Class L Locomotives.



ARRANGEMENT OF GRATES AND ASH PAN FOR ANTHRACITE COAL-PENNSYLVANIA RAILROAD.

For anthracite coal 10 shaking grates are used, occupying the entire length of the firebox, and for bituminous coal the forward end for about 33 inches is taken up by dead plates, back of which is a perforated drop grate 14 inches wide. In some of the later types of engines it has been found necessary to increase the number of shaking grates in order to prevent the coal from being dragged up towards the tube sheet by the draft, but the ash pan and grate-bearer arrangement has not been changed. For bituminous coal the grate fingers are 10 inches long, measured from the end of one of them to the end of the one opposite to it, the bars are $\frac{7}{8}$ inch wide and the spaces between them are of the same width as the bars. The grates are sometimes connected and operated together, and sometimes are divided into two sections, depending upon the number of shaking bars used. For anthracite coal the grates



Detail of Anthracite Grate Bar.

are divided into three sections, the fingers of the individual bars being 10 $\frac{1}{8}$ inches long and $\frac{3}{4}$ inch wide, with spaces 1 $\frac{1}{16}$ inches wide.

The grate bars are carried by bearing castings, formed into flanges at their bottom edges for the attachment of the ash pans. These castings are held to the side of the firebox by studs, and are also held by lugs bolted to the bottom of the mud ring. Special efforts are made to close up all openings around the sides of the firebox, to exclude cold air from coming into contact with the firebox sheets, and also to keep the flame away from them. The access of air to the firebox close to the sheets causes high local heating, that resembles blow-pipe action and shortens the life of the sheets. These grate bearers are grooved to receive a rope of asbestos packing between the castings and the firebox sheets, making a tight joint around the edges of the grates.

The ash pans are of plate, with angle frames, and they are bolted to the flanges of the grate bearer frame. Additional safety brackets, bolted to the under faces of the engine frames, are used to prevent the ash pan from falling in case of breakage of the grate bar frame, and the weight of the grate, coal and ash pan is not carried exclusively by the studs that secure the grate supports to the firebox sheets. The damper openings are large, permitting of easily cleaning out the ashes.

In this design the dampers slide vertically. They are of cast iron and fit closely in grooves. Their weight is balanced, in order to render them easy of operation. While the arrangement of dampers at the front and rear ends of the ash pan works very well for bituminous coal, it does not give entire satisfaction with anthracite, and the drawing of the latter arrangement shows the dampers in the front of the front half and also in the front of the rear half of the pan, the rear portion being extended downward below the level of the front portion. The same damper rigging and cast iron sliding dampers are used in both cases. This mechanism, while rather elaborate, has been found satisfactory, and it does not get out of order. Its chief feature, aside from tightness when closed, is the ease of adjustment by means of the notched rods extending through the deck of the cab. The rods are held by latches that are encased in the housings which guide the rods, and coal is prevented from clogging the latches. To lower a rod, the man places his foot on the opposite end of the bell crank that forms the latch, releasing it.

The shaking levers for operating the grates are permanently attached to the shaking shafts, and when raised to a horizontal position the slot in the head engages with the crank on the top of the shaft, but when out of use the lever hangs vertically, and before putting it into this position the grates must be returned to their normal position. This is to protect the tips of the grate bars from being burned by careless firemen. The design throughout is substantial, and is worthy of being considered permanent construction, which is too much to say of common practice in this regard.

NEW YORK RAILROAD CLUB.

Mr. Charles Hansel, M. Am. Soc. C. E., General Manager of the combined National and Union Switch and Signal companies, read an able and comprehensive paper on railway signaling at the January meeting of the New York Railroad Club, illustrated by stereopticon. The paper combined technical signaling engineering with elementary explanation of the mechanical interlocking and presentation of the principles involved in the use of the electric train staff. The author gave operating men a great deal to think about, particularly in connection with the definitions of the home block and advance block signals established by the American Railway Association, and suggested the use of a distinctive semaphore signal for the block signal where the home signal is also used. This signal has two arms on the same spindle, the front one having a square end and the other a notched end. The paper was suggestive, and copies should be secured by those who have to do with signaling and train operation.

COMPOUND CONSOLIDATION LOCOMOTIVES, NORTHERN PACIFIC RAILWAY.

The Schenectady Locomotive Works have just built 14 two-cylinder compound consolidation engines for the Northern Pacific Railway, the design of which is interesting in comparison with the powerful compounds of the mastodon type by the same builders, illustrated in our issue of March, 1897, page 97. This road has considered the compound locomotive with special care, and its past and future experience with a large number of engines of this type may be studied with profit.

Through the courtesy of Mr. William Forsyth, Superintendent of Motive Power of the road, we have received a photograph and particulars of the new type that is known as Class Y. We understand that the same boiler is used, with 2,923 square feet of heating surface. The total weight of the Class Y is 3,200 pounds more than that of Class X, the mastodons, and the weight on the drivers of Class Y is more by 19,000 pounds. The weight per driving wheel of Class Y is 21,125 pounds, which is 2,375 pounds greater per wheel than that of Class X. These weights render the new design suitable for pushing on heavy grades and also for road work. The cylinders of both types have the same diameter, 23 and 34 inches, but the stroke of Class Y is 34 inches, an increase of 4 inches over Class X, while the driving wheels are of the same diameter in both. We are informed that the new engines are expected to develop a drawbar pull of 40,000 pounds at a speed of 10 miles per hour. The working steam pressure will probably be about 210 pounds per square inch, although the boilers are built to carry 225 pounds. The small diagram of the engine gives the chief dimensions and the photograph shows the engine to be remarkably symmetrical for a large one. The tires of the second and third pairs of driving wheels are plain, the flanges of the forward tires being set $\frac{3}{8}$ inch narrow in gauge in order to throw more of the work of guiding the engine upon the truck wheels. It will be noticed that the sand boxes used in backing are hung under the running boards.

General Dimensions.

Gauge	4 ft. 8 $\frac{1}{2}$ in.
Fuel	Bituminous coal
Weight in working order.....	189,200 lbs.
on drivers.....	169,000 lbs.
Wheel base, driving.....	14 ft. 8 in.
" " rigid.....	14 ft. 8 in.
" " total.....	23 ft. 3 in.

Cylinders

Diam. of cylinders.....	H. P. 23 in. L. P. 34 in.
Stroke of piston.....	34 in.
Horizontal thickness of piston.....	4 $\frac{1}{2}$ and 5 $\frac{1}{2}$ in.
Diam. of piston rod.....	3 $\frac{1}{2}$ in.
Kind " " packing.....	Cast iron
Size of steam ports.....	H. P. 18 in. x 1 $\frac{1}{2}$ in. L. P. 23 in. x 2 $\frac{1}{2}$ in.
" " exhaust ".....	H. P. 18 in. x 3 in. L. P. 23 in. x
" " bridges.....	1 $\frac{1}{2}$ in.

Valves.

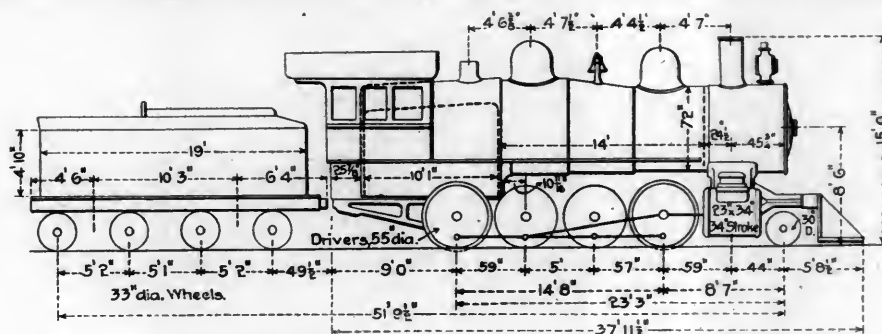
Greatest travel of slide valves.....	6 in.
Outside lap " " ".....	H. P. 1 $\frac{1}{4}$ in. L. P. 1 in.
Inside " " ".....	1 $\frac{1}{4}$ in.
Lead of valves in full gear.....	$\frac{1}{8}$ in. blind

Wheels, Etc.

Diam. of driving wheels outside of tire.....	55 in.
Metal " " centers.....	Cast steel
Tire held by.....	Shrinkage
Driving box material.....	Main, cast steel;
1st, 2d and 4th, steeled cast iron.	
Diam. and length of driving journals.....	Main, 9 in. diam.
1st, 2d and 4th, 8 $\frac{1}{2}$ in. dia. x 10 in.	
" " " " side rod crank pin journals.....	2d, 5 $\frac{1}{2}$ in. x 5 in.;
1st and 4th, 5 in. dia. x 3 $\frac{3}{4}$ in.	
" " " " main crank pin journals—Main, side, 7 $\frac{1}{2}$ in. x 5 $\frac{1}{4}$ in.; 6 $\frac{1}{2}$ in. diam. x 6 in.	
Engine truck, kind.....	2 wheel swing bolster
journals.....	6 in. diam. x 11 in.
Diam. of engine truck wheels.....	30 in.

Boiler.

Style.....	Extended wagon top
Outside diam. of first ring.....	72 in.
Working pressure.....	225 lbs.
Fire box, length.....	120 x 16 in.
" " width.....	42 in.
" " depth.....	F., 77 in.; B., 73 $\frac{1}{2}$ in.
" " plates, thickness—sides, 5-16 in.; back, 5-16 in.; crown, 3 $\frac{1}{2}$ in.; tube sheet, 1 $\frac{1}{2}$ in.	
" " water space—front, 4 $\frac{1}{2}$ in.; sides 3 $\frac{1}{2}$ to 4 in.; back, 3 $\frac{1}{2}$ to 4 $\frac{1}{2}$ in.	
" " crown staying.....	Radial stays, 1 $\frac{1}{4}$ in.
" " stay bolts.....	Ulster special iron, 1 in. diam.
Tubes, number of.....	330
diam.	14 ft.
" length over tube sheets.....	144 in



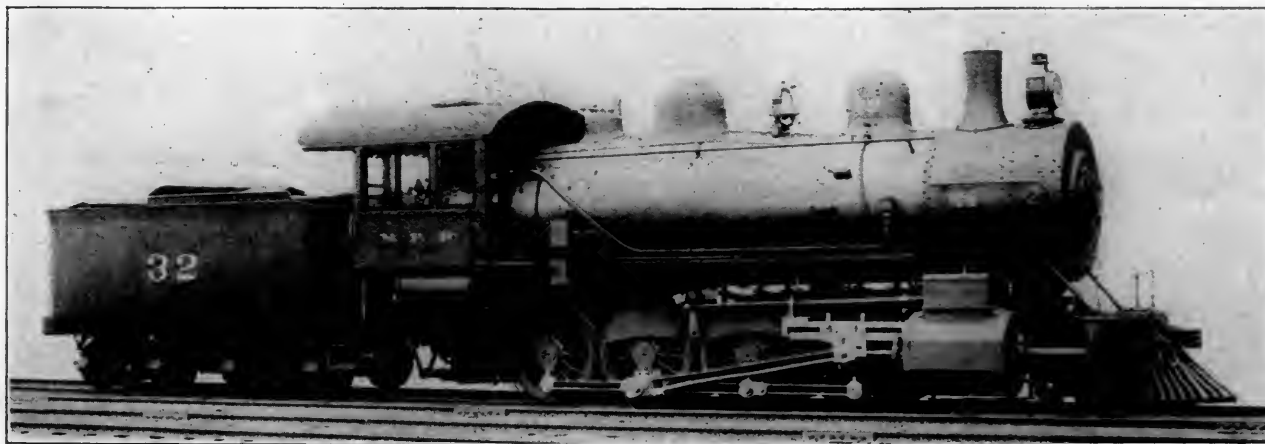
Compound Consolidation Locomotive, Class Y.—Northern Pacific Railway.

Fire brick, supported on.....	2 water tubes
Heating surface, tubes.....	2,705.2 sq. ft.
" " arch tubes.....	15.3 "
" " fire box.....	202.9 "
" " total.....	2,923.4 "
Grate surface.....	35 "
Exhaust, nozzles.....	5 1/4 in., 5 1/2 in. and 5 3/4 in. diam.
Smoke stack, inside diam.....	18 1/2 in. at top, 16 in. near bottom
" " top above rail.....	15 ft.

Tender.

Weight, empty.....	44,850 lbs.
Wheels, number of.....	8
" " diam. of.....	33 in.
Journals, diam. and length.....	5 in. diam. x 9 in.
Wheel base.....	15 ft. 8 in.

present cost of electric power to be from 3½ to 7½ cents per horse-power hour, depending upon the quantity used. The cost of fuel for a steam engine on a basis of 6 pounds of coal per horse-power is the equivalent of 1 1-5 cents per horse-power hour, but this economy cannot be obtained in small engines that are in most common use. Mr. Whitney estimates the average consumption of small engines at about 10 pounds of coal per horse-power hour when actually at work, and the cost of the power at 2 cents for the same unit against 1 1-5 cents for the gas engine. This is considered as the beginning



Compound Consolidation Locomotive—Northern Pacific Railway.

WILLIAM FORSYTH, Superintendent Motive Power.

SCHENECTADY LOCOMOTIVE WORKS, Builder.

Tender frame.....	10 in. steel channel
trucks—Center bearing, double I-beam bolster, with side	
bearings on back truck.....	5,500 gals.
Water capacity.....	8 tons
Coal.....	51 ft. 9 1/2 in.
Total wheel base of engine and tender.....	
Engine equipped with McIntosh blow-off cock, Detroit cylinder	
lubricator, American outside equalized brake on all drivers,	
operated by air; Westinghouse air brake on tender and for	
train, Magnesia sectional lagging on boiler and cylinders,	
Gollmar bell ringer and Ashcroft steam gauge.	

CHEAPER GAS AND THE FUTURE OF THE GAS ENGINE.

Cheaper gas may be expected to induce a general increase in the use of gas engines, and a movement now on foot in Boston may exert a marked influence in this direction. The "Engineering Record" states that Mr. Henry M. Whitney, President of the Brookline Gas Light Company, who also controls large coal resources in Nova Scotia, has asked the city authorities of Boston for the privilege of supplying coal gas of 18 candle power containing less than 10 per cent. of carbonic oxide, at a rate of 75 cents per thousand cubic feet when used in gas engines for power purposes. The price is to be 1 1-5 cents per horse-power hour in gas engines up to 100 horse-power, 1 1-10 cents in engines from 100 to 200 horse-power, and in engines of more than 200 horse power the cost will be 1 cent per horse-power hour. Mr. Whitney states the

of a movement in the direction of cheap gas that is likely to spread, and if so, its influence on the future of the gas engine will be powerful. At these rates power may be had for manufacturing purposes at an advantage over steam or electricity when produced by steam.

The estimated cost of the electric railway up the Jungfrau is \$2,000,000, about one-half of which is to be expended in tunneling. The forecast of traffic receipts give an annual income of about \$150,000, at the rate of about \$7 per passenger for the round trip to the summit. The line will be about eight miles long, so that the rate per mile will be about 45 cents. Considering the nature of the route, however, says the "Mechanical World," the charge is not excessive. The last 240 feet of the ascent is to be made by a vertical lift. Electric elevators of American make will here convey the passengers to the surface at the very summit of the mountain. The tunnels along the route will be 14 feet in diameter, and will be lighted by electric lamps, supplied by wires with a current separate from that of the railway. Storage batteries will be placed at each station for lighting purposes, and to provide for emergencies. The electric equipment of the entire line will be most complete, and the railway will be the most remarkable piece of railway construction thus far attempted.

are divided into three sections, the fingers of the individual bars being $10\frac{1}{4}$ inches long and $\frac{3}{4}$ inch wide, with spaces 1 1-16 inches wide.

The grate bars are carried by bearing castings, formed into flanges at their bottom edges for the attachment of the ash pans. These castings are held to the side of the firebox by studs, and are also held by lugs bolted to the bottom of the mud ring. Special efforts are made to close up all openings around the sides of the firebox, to exclude cold air from coming into contact with the firebox sheets, and also to keep the flame away from them. The access of air to the firebox close to the sheets causes high local heating, that resembles blow-pipe action and shortens the life of the sheets. These grate bearers are grooved to receive a rope of asbestos packing between the castings and the firebox sheets, making a tight joint around the edges of the grates.

The ash pans are of plate, with angle frames, and they are bolted to the flanges of the grate bearer frame. Additional safety brackets, bolted to the under faces of the engine frames, are used to prevent the ash pan from falling in case of breakage of the grate bar frame, and the weight of the grate, coal and ash pan is not carried exclusively by the studs that secure the grate supports to the firebox sheets. The damper openings are large, permitting of easily cleaning out the ashes.

In this design the dampers slide vertically. They are of cast iron and fit closely in grooves. Their weight is balanced, in order to render them easy of operation. While the arrangement of dampers at the front and rear ends of the ash pan works very well for bituminous coal, it does not give entire satisfaction with anthracite, and the drawing of the latter arrangement shows the dampers in the front of the front half and also in the front of the rear half of the pan, the rear portion being extended downward below the level of the front portion. The same damper rigging and cast iron sliding dampers are used in both cases. This mechanism, while rather elaborate, has been found satisfactory, and it does not get out of order. Its chief feature, aside from tightness when closed, is the ease of adjustment by means of the notched rods extending through the deck of the cab. The rods are held by latches that are encased in the housings which guide the rods, and coal is prevented from clogging the latches. To lower a rod, the man places his foot on the opposite end of the bell crank that forms the latch, releasing it.

The shaking levers for operating the grates are permanently attached to the shaking shafts, and when raised to a horizontal position the slot in the head engages with the crank on the top of the shaft, but when out of use the lever hangs vertically, and before putting it into this position the grates must be returned to their normal position. This is to protect the tips of the grate bars from being burned by careless firemen. The design throughout is substantial, and is worthy of being considered permanent construction, which is too much to say of common practice in this regard.

NEW YORK RAILROAD CLUB.

Mr. Charles Hansel, M. Am. Soc. C. E., General Manager of the combined National and Union Switch and Signal companies, read an able and comprehensive paper on railway signaling at the January meeting of the New York Railroad Club, illustrated by stereopticon. The paper combined technical signal engineering with elementary explanation of the mechanical interlocking and presentation of the principles involved in the use of the electric train staff. The author gave operating men a great deal to think about, particularly in connection with the definitions of the home block and advance block signals established by the American Railway Association, and suggested the use of a distinctive semaphore signal for the block signal where the home signal is also used. This signal has two arms on the same spindle, the front one having a square end and the other a notched end. The paper was suggestive, and copies should be secured by those who have to do with signaling and train operation.

COMPOUND CONSOLIDATION LOCOMOTIVES, NORTHERN PACIFIC RAILWAY.

The Schenectady Locomotive Works have just built 14 two-cylinder compound consolidation engines for the Northern Pacific Railway, the design of which is interesting in comparison with the powerful compounds of the mastodon type by the same builders, illustrated in our issue of March, 1897, page 97. This road has considered the compound locomotive with special care, and its past and future experience with a large number of engines of this type may be studied with profit.

Through the courtesy of Mr. William Forsyth, Superintendent of Motive Power of the road, we have received a photograph and particulars of the new type that is known as Class Y. We understand that the same boiler is used, with 2,923 square feet of heating surface. The total weight of the Class Y is 3,200 pounds more than that of Class X, the mastadons, and the weight on the drivers of Class Y is more by 19,000 pounds. The weight per driving wheel of Class Y is 21,125 pounds, which is 2,375 pounds greater per wheel than that of Class X. These weights render the new design suitable for pushing on heavy grades and also for road work. The cylinders of both types have the same diameter, 23 and 34 inches, but the stroke of Class Y is 34 inches, an increase of 4 inches over Class X, while the driving wheels are of the same diameter in both. We are informed that the new engines are expected to develop a drawbar pull of 40,000 pounds at a speed of 10 miles per hour. The working steam pressure will probably be about 210 pounds per square inch, although the boilers are built to carry 225 pounds. The small diagram of the engine gives the chief dimensions and the photograph shows the engine to be remarkably symmetrical for a large one. The tires of the second and third pairs of driving wheels are plain, the flanges of the forward tires being set $\frac{3}{4}$ inch narrow in gauge in order to throw more of the work of guiding the engine upon the truck wheels. It will be noticed that the sand boxes used in backing are hung under the running boards.

General Dimensions.

Gauge	4 ft. 8½ in.
Fuel	Bituminous coal
Weight in working order	189,200 lbs.
" on drivers	169,000 lbs.
Wheel base, driving	14 ft. 8 in.
" " rigid	14 ft. 8 in.
" " total	23 ft. 3 in.

Cylinders

Diam. of cylinders	H. P. 23 in. L. P. 34 in.
Stroke of piston	34 in.
Horizontal thickness of piston	4½ and 5½ in.
Diam. of piston rod	3½ in.
Kind " packing	Cast iron
Size of steam ports	H. P. 18 in. x 1½ in. L. P. 23 in. x 2¼ in.
" " exhaust	H. P. 18 in. x 3 in. L. P. 21 in. x 3 in.
" " bridges	1½ in.

Valves.

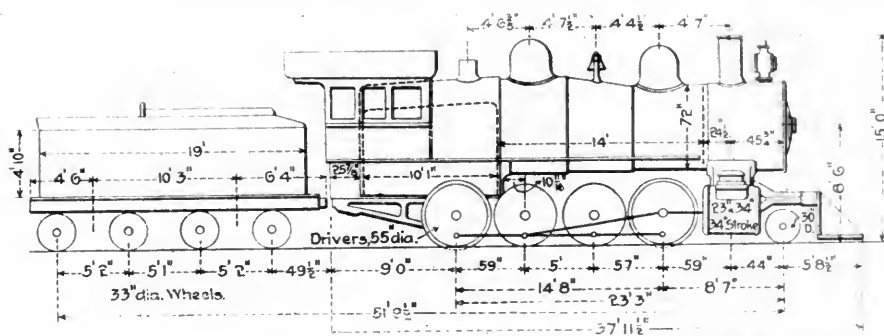
Greatest travel of slide valves	6 in.
Outside lap	H. P. 1¼ in. L. P. 1 in.
Inside " " "	¾ in.
Lead of valves in full gear	¼ in. blind

Wheels, Etc.

Diam. of driving wheels outside of tire	55 in.
Metal " " centers	Cast steel
Tire held by	Shrinkage
Driving box material	Main, cast steel;
	1st, 2d and 4th, steered cast iron.
Diam. and length of driving journals	Main, 9 in. diam.
	1st, 2d and 4th, 8¼ in. dia. x 10 in.
" " " " side rod crank pin journals	2d, 5½ in. x 5 in.;
	1st and 4th, 5 in. dia. x 3½ in.
" " " " main crank pin journals—Main, side,	7¼ in. x 5½ in.; 6¼ in. diam. x 6 in.
Engine truck, kind	2 wheel swing bolster
journals	6 in. diam. x 11 in.
Diam. of engine truck wheels	30 in.

Roller.

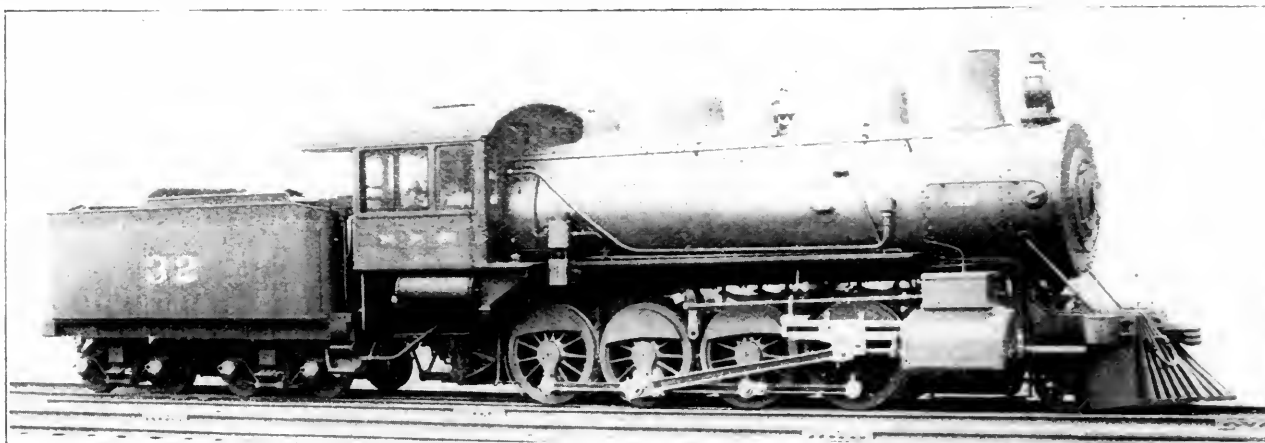
Style	Extended wagon top
Outside diam. of first ring	72 in.
Working pressure	225 lbs.
Fire box, length	120 x 3-16 in.
" " width	12 in.
" " depth	F. 77 in.; B. 73½ in.
" " plates, thickness—sides, 5-16 in.; back, 5-16 in.; crown,	¾ in.; tube sheet, 1½ in.
" " water space—front, 4½ in.; sides 3½ to 4 in.; back, 3½	to 4½ in.
" " crown staying	Radial stays, 1¼ in.
" " stay bolts	Ulster special iron, 1 in. diam.
Tubes, number of	330
" diam.	14 ft.
" length over tube sheets	144 in.



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Fire brick, supported on.....	2 water tubes
Heating surface, tubes.....	2,705.2 sq. ft.
“ “ arch tubes.....	15.3
“ “ fire box.....	202.9
“ “ total.....	2,923.4
Grate surface.....	35
Exhaust, nozzles.....	5¼ in., 5½ in. and 5¾ in. diam.
Smoke stack, inside diam.....	18½ in. at top, 16 in. near bottom
“ “ top above rail.....	15 ft.
Tender.	
Weight, empty.....	44,850 lbs.
Wheels, number of.....	8
“ diam. of.....	33 in.
Journals, diam. and length.....	5 in. diam. x 9 in.
Wheel base.....	15 ft. 8 in.

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Tender frame.....	10 in. steel channel
trucks—Center bearing, double I-beam bolster, with side bearings on back truck.	
Water capacity.....	5,500 gals.
Coal.....	8 tons
Total wheel base of engine and tender.....	51 ft, 9½ in.
Engine equipped with McIntosh blow-off cock, Detroit cylinder lubricator, American outside equalized brake on all drivers, operated by air; Westinghouse air brake on tender and for train, Magnesia sectional lagging on boiler and cylinders, Gollmar bell ringer and Ashcroft steam gauge.	

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COMMUNICATIONS.

POWERFUL PASSENGER LOCOMOTIVES FOR FAST TRAINS.

Editor American Engineer:

I have been much interested in reading your article in the present issue on "Powerful Passenger Locomotives for Fast Trains," proof of which was kindly sent me. I believe that your analysis of the results obtained by Mr. Vauclain and myself is correct.

This matter is, in my opinion, one of much importance to designers of high-speed locomotives, inasmuch as it points to the fact that by giving attention to the details of the valve motion, valves and ports, much more power can be gotten out of the cylinders of our locomotives at high speed than has heretofore been available. The conclusions by Professor Goss a year or two since were that there was a rapid falling off in the power after reaching a speed of from 180 to 200 revolutions per minute, due to the defective distribution of steam, which, in turn, resulted from the wire drawing caused by insufficient port areas and defective valve motion. These conditions were, I believe, true for locomotives built a few years ago, and are perhaps true for a great many engines now running. The later results, obtained with the Vauclain system of compounding, show very clearly what can be done and what is being done to correct these evils by more careful design and construction of valve motion, and better arrangement of valves and ports.

All this is, it seems to me, quite apart from the question of boiler power. The failure of our locomotives at high speed has generally been a failure to get sufficient work out of the cylinders. If, as has been shown, it is possible to obtain more power with a given size of cylinder, then it is necessary to furnish a boiler which will supply sufficient steam to meet the demand. This is, perhaps, the simpler end of the problem.

To guard against a possible misapprehension of the results set forth in my paper, I desire to call attention to the fact that the diagram, Fig. 1, which apparently shows the power curve to be a straight line passing through the origin, is, though correct, likely to be misinterpreted. It will be noticed that the scales of the ordinates and abscissæ do not begin at zero. If the diagram be continued to include the origin, it will be seen that the power curves do not pass through the latter, but above it. The diagram shows, then, that the increase of power with speed is at a constant ratio, but that this ratio is less than 1.

Yours very truly,

R. A. SMART,

Associate Professor of Experimental Engineering.
Purdue University, January 18, 1899.

CAST IRON IN RAILWAY PRACTICE.

Editor "American Engineer":

The interesting paper in your current issue on "Cast Iron in Railway Practice," referring to the remarkable effect of adding ferro-manganese to car wheel iron in the ladle, recalls to my recollection an extended investigation made 15 years ago upon this subject. I inclose herewith, thinking it may be interesting, the first record in print of these experiments contained in an abstract of a lecture given at the Franklin Institute in March, 1883:

Manganese is commonly supposed to exert a hardening tendency upon pig iron, but experience has taught me to regard this as another mistaken notion, it undoubtedly produces a marked effect upon the character of the white crystalline structure. You may readily recognize "a manganese chill" by its coarse lamellar or foliated filaments and by the tendency which it produces to form white iron or "hard spots" in isolated places throughout the gray portion of a casting. Manganiferous pig iron has been used to produce chilled castings, but it does not make a durable wearing surface; the chilled tread of a car wheel, for example, produced by this method, presents to the eye, when broken through the section, a handsome appearance, but the white metal is comparatively soft; it may be easily bored, and, what is more serious, it crumbles readily under the impact of rapid shocks on the rail.

A remarkable effect is produced upon the character of hard iron by adding to the molten metal, a moment before pouring it into a mold, a very small quantity of powdered ferro-manganese, say 1 lb. of ferro-manganese in 600 lbs. of iron, and

thoroughly diffusing it through the molten mass by stirring with an iron rod. The result of several hundred carefully conducted experiments which I have made enables me to say that the transverse strength of the metal is increased from 30 to 40 per cent., the shrinkage is decreased from 20 to 30 per cent. and the depth of the chill is decreased about 25 per cent., while nearly one-half of the combined carbon is changed into free carbon; the percentage of manganese in the iron is not sensibly increased by this dose, the small proportion of manganese which was added being found in the form of oxide in the scoria. The philosophical explanation of this extraordinary effect is, in my opinion, to be found in the fact that the ferro-manganese acts simply as a deoxidizing agent, the manganese seizing any oxygen which has combined with the iron, forming manganic-oxide, which, being lighter than the molten metal, rises to the surface and floats off with the scoria. When a casting which has been artificially softened by this novel treatment is re-melted, the effect of the ferro-manganese disappears and hard iron results as a consequence.

The late Wm. Wilmington brought some powdered ferro-manganese to the late Geo. Whitney, of Philadelphia, about 1883, and requested permission "to pour a handful into the head box of a car wheel mold, when the mold was partly filled." This he did, and the wheel was broken up for examination. The effect of the ferro-manganese on the gray metal of the plate was plainly visible as far as it penetrated, and the matter was placed in my hands for investigation and report.

Mr. Wilmington, unfortunately, did not understand the ra-



Showing "Too High Chilling."

tionale of his process at all, and, I believe, failed to reap any advantage from his original discovery; he patented a process—as noted in the lecture—which was never practiced, and the modification of adding ferro-manganese in the ladle, proposed and adopted by me, was strenuously opposed by him. Gradually knowledge of the process spread abroad, and in time it came into almost universal use in car wheel establishments.

The table on page 8 of your magazine, giving "tests of wheel iron with ferro-manganese," shows that a little over one-half of the combined carbon is changed into graphitic carbon by the use of the largest percentage of ferro-manganese (see No. 6). This agrees pretty well with the results published in 1883, using a smaller percentage of ferro-manganese, viz.: "Nearly one-half of the combined carbon is changed into free carbon."

The half-tone illustration shows a section of a car wheel made from a re-melt of old wheels, in which the metal was entirely too high-chilling, and even mottled, until softened by the addition of about 1 lb. of ferro-manganese in a ladle holding about 600 lbs. of iron.

A. E. OUTERBRIDGE, JR.

Philadelphia, January 4, 1899.

THE M. C. B. COUPLER ABROAD.

Editor American Engineer.

While our master car builders are wrestling with the problem of strengthening and standardizing the vertical plane coupler, it may be in order to review the situation abroad and see what our fellow craftsmen in foreign lands are doing in regard to the car coupler question. As is well known, American freight cars are of so much greater capacity than those of other countries that the phase of the problem at present confronting us is of no immediate concern to our friends abroad, with their 10 to 20 ton equipment, but sooner or later they will profit by the experience we have so dearly bought, and it is safe to predict that when the automatic car coupler makes its appearance on the monthly shop requisitions of Eu-

European railroads it will be the latest and most improved type of the M. C. B. coupler. That the time is not far off present indications show.

Our consuls abroad take care to report that American cheese does not sell as well in England as the Canadian, and that American linseed oil is making good headway in France, and that last year's apple crop in Germany fell below the average. The bicycle market is given its share of consular attention, and American tool and machine makers receive an occasional hint. But the railway supply trade, which has grown to such vast proportions in this country, is seldom touched upon in these reports, because the consuls are not railroad men and do not come in contact with railroad men as they do with merchants and commercial men, and it is not to be expected that they can give intelligent information about matters with which they are unfamiliar. The large manufacturers of railroad supplies having their own representatives abroad, permanently located or on periodical trips, are able to take care of their own interests, but those who have not yet developed a foreign trade are at a great disadvantage in any attempt to do so without reliable advice how and where to meet the wants of the railroads abroad. The principal source of information in that line for our manufacturers of railroad supplies in general is the English press, the English engineering and trade journals, in occasional reports and notes dealing with the needs of the railroads of their own country. It is a conspicuous fact, however, that the English railroads are the most conservative on earth, and these press reports do not therefore always reflect the true situation on the Continent.

A short time ago the papers reported that on account of the alarming number of injuries to employees on the English railroads, as compared with American, legislative action would probably be taken for the purpose of compelling the use of automatic couplers, but adding that the railroads were expected to enter a vigorous protest because of the cost. In Germany, however, the subject is considered from another point of view. The question there is not whether automatic couplers shall be introduced, but when and how. The German railroad officials have been watching our M. C. B. coupler committees as eagerly as the coupler manufacturers have been watching each other. The European type of car coupling at present in use would not materially interfere with the application of automatic couplers, where a suitable draft rigging for the latter can be applied below the present draft gear, which would remain undisturbed in order to connect with cars equipped for its use only.

In Sweden the Government is preparing to build a number of refrigerator cars, for the purpose of meeting the altered demands of the kingdom's large beef export trade. Until recently cattle have been shipped to England alive, but on account of a hoof disease prevailing in Europe this is now prohibited; hence the need of refrigerator cars to retain their trade. These cars will probably be as large as the American, and the understanding is that they will be equipped with automatic couplers in order to facilitate a rapid handling of the cars.

In Italy the freight cars are of the American type to a large extent, and the vertical plane couplers could be applied to them without difficulty, but as the railroads there do not pay expenses, there is no money in sight to spend for improvements.

Progressive little Japan has taken still one step nearer. More than one coupler manufacturer in this country has received blue prints of its freight cars, with request to submit figures for the cost of his coupler and a draft rigging for the same, suitable for the construction of these cars.

Such signs of the times indicate that before long the automatic coupler will be an established fact in every country where railroading is carried on to any extent. In the light of the experience here, it is not probable that any but vertical plane couplers of the M. C. B. type will be considered abroad, and as almost every possible variation of this class has been conceived and tried in this country it is scarcely possible that any new forms can be brought out.

Few, if any, of the M. C. B. couplers are patented, and in most cases the time set for applying for such patents has expired. The coupler manufacturer who desires to market his product in foreign countries may, therefore, have to go into open competition with native enterprises. It is not to be hoped that the railroads abroad are willing or able to pay higher prices, commensurate with the freight and import duties, than our own railroads can afford, so that the manufacturer would either have to be satisfied with less profit or establish foreign

branch factories to supply this trade, as the Westinghouse Air Brake Company and some other firms have done for their specialties.

The Paris Exposition next year will provide our coupler manufacturers with the needed opportunity at the right time to feel their way for prospective European trade, but it is unnecessary to say that only those that are thoroughly protected by European patents, or that in lieu of such protection can command sufficient capital to fight competition, need to enter the field with hope of financial returns.

EDW. GRAFSTROM.

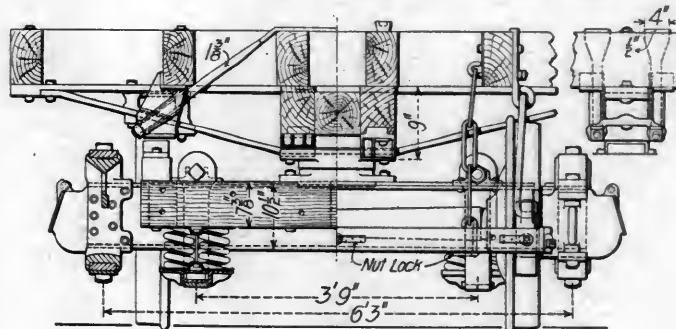
Columbus, Ohio, January 19, 1899.

TRUSSED BODY BOLSTER AND SPRING STIRRUPS FOR FREIGHT CARS.

C. & N. W. Ry.

The accompanying engraving illustrates an arrangement of body bolsters and truck bolster spring supports devised by Mr. C. A. Schroyer, Superintendent of the Car Department, Chicago & Northwestern Railway, and used in construction of standard cars of various capacities. The object of the trussed body bolster is primarily to secure additional strength without adding materially to the weight, and at the same time to preserve dimensions that are in general use on the cars of the road.

The body bolster is reinforced by two truss rods having a rectangular section $\frac{1}{2}$ by 4 inches at the center where they pass over the center sills, the bodies being round, $1\frac{1}{2}$ inches in diameter, and passing through malleable iron castings, which also form the body side bearings. These castings also form a seat for the nuts at the ends of the truss rods. They



Trussed Body Bolster and Spring Stirrups.
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MR. C. A. SCHROYER, Supt. Car Department.

were designed with a view of resisting the pull on the truss rods and the side bearing castings are of very substantial construction, having a flange at each side which abuts against the outer face of the intermediate sill to take the thrust from the rods, a part of which is also resisted by shearing action on the side bearing bolts. The form of the side bearing is such that it may be slipped in place without interfering with the construction of the bolster, and it adds very little to the cost. It is said that the outer ends of the bolster may be easily raised by tightening the nuts on these rods. Mr. Schroyer is to be congratulated on his easy and cheap solution of the limber bolster question, with its attendant problem of keeping side bearings apart. This trussing ought to have wide application in stiffening weak bolsters, even beyond the capacity for which they were made and under which they may have failed. It certainly may be made the means of saving light bolsters now running, to an extended period of usefulness, and it is equally certain that there is no cheaper or better plan so far evolved that will answer the purpose of giving a new life to the plate bolster. There are thousands of them in service that would have been thrown out long ago but for the immense cost involved.

Mr. Schroyer has substituted short stirrups for the usual spring plank in this truck, and finds that it saves unnecessary weight.

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C., C., C. & St. L. Ry. and Purdue University.

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It is clear that elaborate trials offered the only possible method for intelligent comparisons of fuel in this case, and we commend the care, and especially the checking, of the work by the double tests. A 20 by 26 inch consolidation engine was used on the road, and the comparative figures of evaporation are given below. The order of values of the coals from this standpoint is the same in both tests, this fact being a source of satisfaction and confidence in the results.

Coal.	Evaporation in lbs. per pound coal.		Coal per 1,000 ton miles Road Tests.		Monthly consumption of Coal in tons per 14,000,000 car miles.	
	Laboratory.	Road.				
E	6.61	6.84	116.800 lbs.		25345.6	
A	6.13	6.41	118.075 "		25622.1	
B	5.87	6.10	126.350 "		27417.6	
D	5.40	5.36	148.725 "		32273.5	
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The data indicate that it is possible for 264 pounds of coal per ton of one of the coals to be wasted from the stack in the form of sparks. Those tests show this result when forcing the boiler to evaporate 10 pounds of water per square foot of heating surface per hour. This will no doubt be a revelation on fuel loss that will strike a hard blow at small heating surfaces when coupled with heavy demands for steam. This has a special significance when compared with a loss of only 75 pounds per ton of fuel from the same causes when the rate of evaporation in the same boiler is but 5 pounds of water per square foot per hour.

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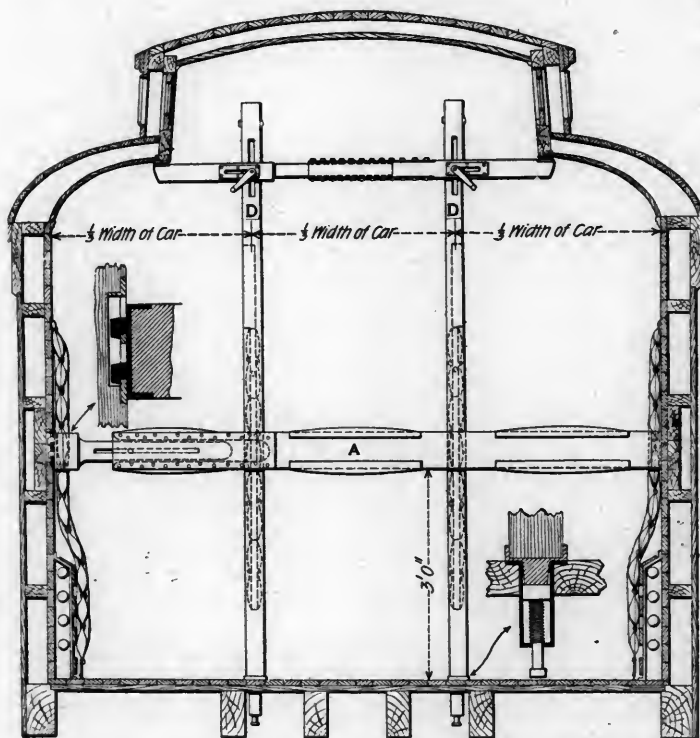
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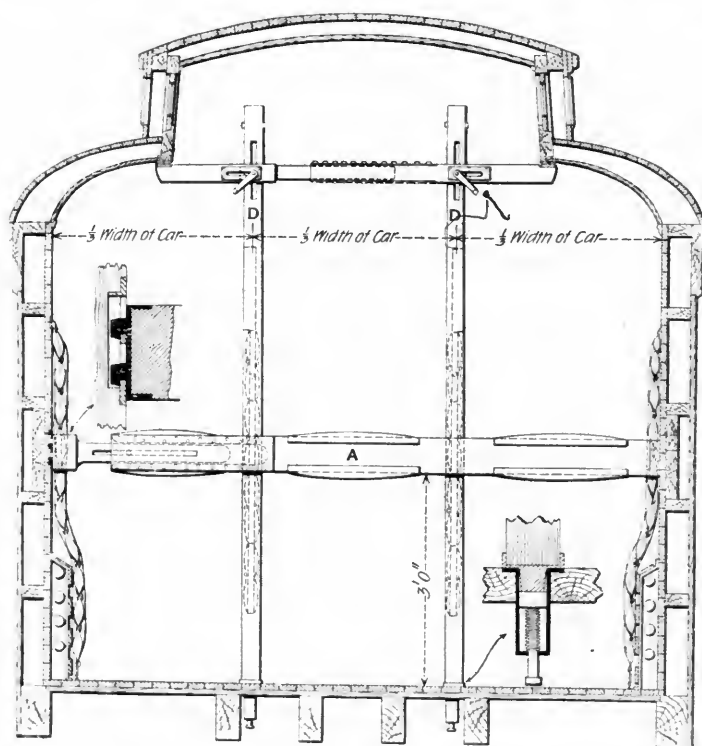
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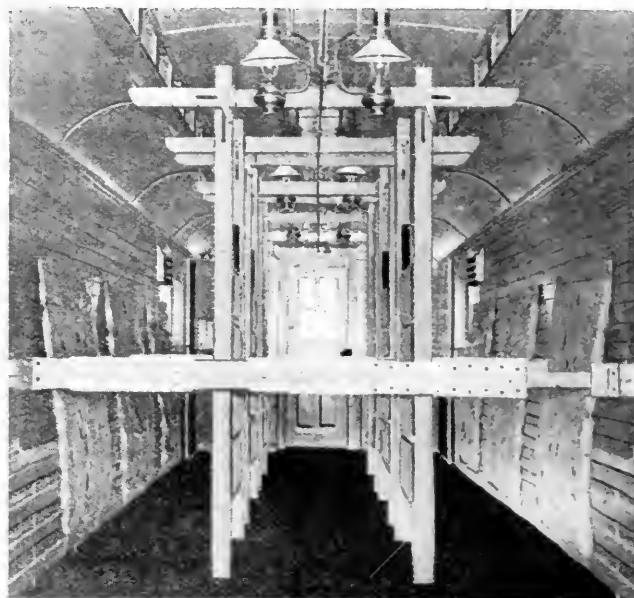
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UNDERHUNG DRIVING SPRING RIGGING.

By L. R. Pomeroy.

It is not long since all driving spring rigging was placed above the frames, but the increasing demands on motive power have forced designers to employ the largest boilers which they could crowd into the limits to which they are restricted. A substantial improvement has been made by placing the fire box on top of the frames, which made the width between the wheels the limiting one, instead of between the frames, where-

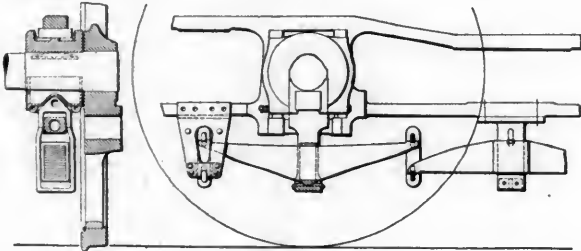


Fig. 1.

by nearly if not quite 8 inches are gained in width. Designers were then forced to employ underhung spring rigging, and so far as such designs have followed the general principles involved in the best arrangements of overhung springs, there has been no more trouble with the underhung than with overhung rigging. The popular and successful type of overhung spring rigging has been the result of a long process of evolution and experience, and it would seem to be good practice to utilize this experience so far as the new conditions permit, and the only arrangements of springs that have been unsatisfactory have been those in which a departure has been made

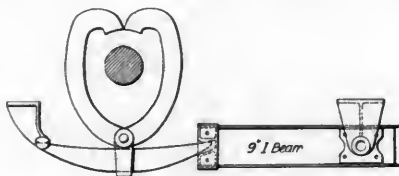


Fig. 2.

from long established and successful precedents. The difficulty is two-fold:

First.—Where driving springs have been so connected as to provide sliding (and chafing) contact at their ends. Hangers or swinging links are provided almost universally as a means of spring suspension in foreign practice, and this principle is commonly employed in engine trucks in preference to permitting the springs to bear at their ends. Recent experience with springs having sliding contacts goes to show that the destruction of the spring is very rapid, and the use of links has demonstrated in a practical way that springs fitted with them

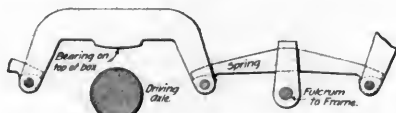


Fig. 3.

do not receive the punishment to which the others are subjected.

Second.—Such an arrangement of springs and equalizers, with reference to their points of suspension as will cause the hangers, connecting the equalizers with springs, to pull away from the vertical plane. Such arrangements cause rapid wear and unsatisfactory movements, because strains are produced for which no provision has been made.

It is unnecessary to dwell upon the effects of these faults, it being sufficient to call attention to the fact that good designing demands the relief of heavy loaded springs of this type, from sliding friction at their ends, and they should also be relieved of the stresses imposed by hangers which pull out of the vertical to an unnecessary extent. There is little or no excuse for the failures that have recently been made, when these principles have been neglected, because this ground has all been gone over thoroughly by others, whose experience

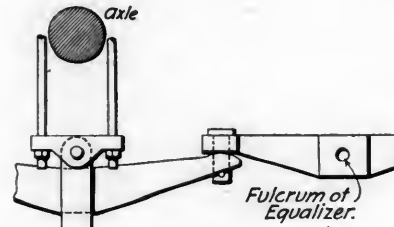


Fig. 4.

has been available to all. For example, Fig. 1 is submitted as a successful example which was made from an engine built over ten years ago. Figs. 2, 3 and 4 illustrate examples where suspension from the spring band is combined with rubbing or chafing at the ends of the springs. Fig. 5 is a conventional diagram to illustrate how the point of suspension influences the path of the hangers.

In Fig. 5 the arc $x x_1$ is the path of the suspension point at

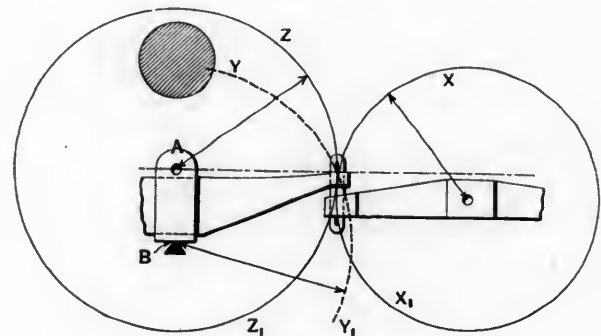


Fig. 5.

the end of the equalizer. Assuming the spring to be hung from the top of band or buckle, as at A, then the path of the suspension point at the end of the spring is an arc represented by Z, Z₁, struck from the center A. The path of the hanger is determined by these arcs, and they are so located as to tend to change the angle between the hanger and the vertical line very rapidly. In a word, the only time the hanger remains

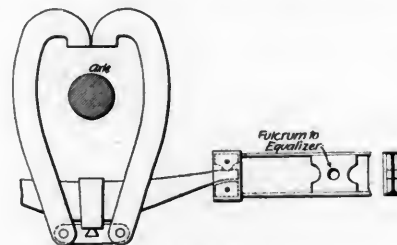


Fig. 6.

vertical is when the engine is at rest; just as soon as any movement occurs the spring and equalizer tend to pull apart.

When the spring rests in a stirrup the center of movement is around or about point "B," and the arc of movement of the suspension point at the end of the spring is located at y, y₁. The radius is slightly increased; this and the lowering of the center of rotation causes the arc y, y₁ to inter-

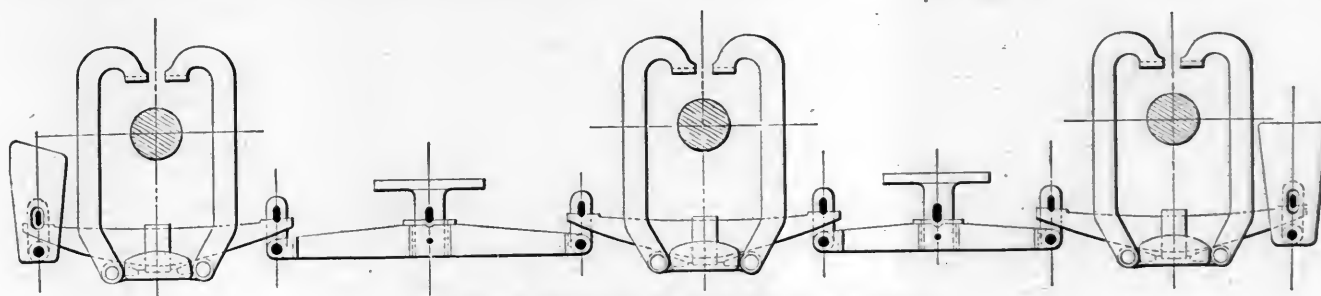


Fig. 7.—Arrangement of Equalizers and Springs.

sect the arc $x x_1$, instead of being nearly tangent to it as before, and the movement of the hanger is so changed as to keep it in a nearly vertical position. Various dimensions may be given for the parts shown in this diagram, but such an arrangement of centers of rotation, or such a combination between length of spring and equalizers, should be selected as will tend to keep the hanger as nearly vertical as possible. When the spring rests on a stirrup, as at B, Fig. 5, it has a bearing on the bottom, and more nearly approximates the conditions existing with the best forms of overhung springs; again, such a bearing tends to produce a more even and deliberate movement of the spring, whereas, when hung from the top of the band at A, the spring is then suspended from a point, which tends to promote a more rapid vibratory movement.

Fig. 6 is added to show a modification of Fig. 2 and Fig. 7 to show an example of good practice.

JOURNAL BOX LIDS.

There appears to be some quiet investigation of the question of dust exclusion by the M. C. B. journal box lid by Messrs. McCarty, Petri and Butler, a committee of the Central Railway Club, whose findings were embodied in a report at the November meeting of the club. Some of their conclusions are given below:

The form of the M. C. B. journal box lid was wrong in principle, and consequently under the usual methods employed in making and fitting freight car boxes and lids it was difficult, if not impossible, to secure a close fitting lid, as the face of the lid and box were irregular in form. In the opinion of the committee a careful consideration of the question would result in the conclusion that the most economical form of journal box would be one having a perfectly flat surface for the lid to rest upon, and where the action of the spring would be most effective. These features were all embodied in the Fletcher lid. It was well understood that the moment a train starts up much dust and dirt that beats against the forward side of the box the lid exposed to this action would be affected to a greater or less extent. This had been overcome by hanging the Fletcher lid at the top and forming a ledge or rib on each side of the box, which effectually resists the action of the dust and dirt, as with this construction there were no exposed joints at the sides of the box.

By a comparative trial on passenger cars, extending over a period of one and a half years, it was shown that boxes with close fitting lids required 50 per cent. less oil and packing than boxes with the M. C. B. form of lid. One form of lid in this comparative test was a cast iron sliding lid, fitting ledges on each side of the box, which, as well as the lid, were machine fitted by an economical process. This lid gave better results than the Fletcher. This sliding lid was not a new form, having been in use for at least 30 years on a railroad where the conditions were most severe in regard to sand and dust. During this long period this lid had shown a saving of over 50 per cent. in the amount of care required in oiling and packing the boxes, as well as an equal saving in the quantity of oil and

packing used, as compared with the M. C. B. lid in the same service.

This test also showed a great saving in wear of the journal, both in diameter and end wear, being a reduction of wear on the parts referred to of 50 per cent. and in many cases more than that, as compared with the M. C. B. lid. The committee did not consider the M. C. B. lid as meeting the requirements for the complete exclusion of dust and dirt.

This report is likely to reopen the box lid question, with the ultimate result of a change in form of what is now the M. C. B. standard, for the reason that the reported oil saving will be a powerful incentive to produce such action. We shall take occasion in this connection to again call attention to the need of a dust excluding device at the rear of a journal box. Protection is required at that point, and the question as to how much that 50 per cent. saving might be increased by the use of an efficient dust guard is a pertinent one, for it is well understood that dust guards are now allowed to run with an area of opening not less, and often greater, than that in the poorest fitting box lid.

The Hon. Chauncey M. Depew, Chairman of the Executive Board of the New York Central & Hudson River Railroad, has been elected United States Senator for New York State. This election of a lifelong railroad man to the council halls of the nation marks a new departure in the politics of this country. The Republican Club, of which Mr. Depew is President, gave the Senator-elect a dinner in honor of his election. Among other speakers on this occasion was Mr. George H. Daniels, General Passenger Agent of the New York Central, who gave in his customary happy manner some of the reasons why the choice of Mr. Depew to represent the people of New York in the Senate was a wise one. Mr. Daniels having been identified with transportation interests from his boyhood, is well qualified to speak of this change in sentiment with regard to railroad men, and among other good things he said: "It is to my mind peculiarly fitting that just at this time, when transportation is occupying so large a place in the public mind, not only in this country, but in every country on the globe, the Empire State of the Union should select as its representative in the most important legislative body in the world a man whose whole life has been spent in the closest association with the transportation interests of the country, and that, notwithstanding the prejudice which has so long existed in the minds of many otherwise fair-minded men against railroad officials as such, the representatives of his party have paid a railroad man the unprecedented compliment of a unanimous vote for the most important position within their gift."

"To think straight and not let one's self be led into tortuous ways by inessential details is, I think, the most difficult thing in affairs mechanical." This paragraph is quoted from the correspondence of a young mechanical engineer, and while it is nothing more or less than "common sense," how uncommon it is to find men who keep this idea in mind in their work. A man who puts such a sentiment into private correspondence may be expected to be successful, and he is successful.

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Mr. G. R. Brown, General Superintendent of the Fall Brook Railway, sends us the most important contribution on the subject of discipline that has ever been published. It is printed in this issue and the words of the founder of "Discipline Without Suspension," after years of experience with the system, are impressive. In his annual report of 1898 to his superiors Mr. Brown said: "Better men, better discipline mean better results." One of the results is the record of the Fall Brook Railway for not in its history having killed or even seriously injured a single passenger.

The communication from Mr. A. E. Outerbridge on another page of this issue on "Cast Iron in Railway Practice," called forth by the article by Messrs. Henderson and Davis in our January number, is of special interest because of the importance of the cast iron car wheel, than which nothing but the improvements in steel rail making has contributed more to the extraordinary development of American railroads. Mr. Outerbridge is entitled to the credit of the introduction of the use

of ferro-manganese, and the publication of the paper read by him before the Franklin Institute in March, 1888, brought inquiries from car wheel manufacturers all over the country leading to the improvement of the wheels. We have been intrusted with the records of the original investigations by Mr. Outerbridge, which were undertaken in 1883, and it was a most elaborate, painstaking and thorough research. It shows how the ground was covered, and indicates the amount of time, thought and money expended in putting a crude suggestion into practicable form. The cast iron wheel with chilled face, as made by the best manufacturers to-day, is a product to be proud of. It is not the result of accident, but of scientific study of the highest character.

There appears to be a renewal of attention to the inspection of watches used in railroad service. While watch inspection and regulation has been practiced on many roads for some years past, and has been found to be most satisfactory in results, it appears that there is a lack of proper appreciation of this safeguard in train management. Watches in the hands of some men are regarded in the same light as any other piece of machinery, and if there is an inherent disposition to let such mechanism take care of itself there is but one result to be expected. For that reason, if no other, compulsory inspection and regulation is an absolute necessity on railroads. The interests at stake are too great to permit of taking chances that are sure to bring disaster to life and property by way of a defective watch, and we are glad to note this revival of interest. We have noted a resentful disposition in some cases to what is termed the paternal tendencies of railroads, but it has been shown only by those who were in chronic opposition to every improvement in the service.

AIR BRAKES ON CARS OF LARGE CAPACITY.

It is not unnatural that the question of the adequacy of present brake power upon freight cars of moderate weight, designed to carry heavy loads to meet the practical requirements of service, should receive some discussion. If the present tendency to increase the capacity of cars should continue, it is possible that the conditions may become such as will warrant increased braking capacity for freight cars. It is, nevertheless, the fact that, so far as the study of the subject of providing different braking powers for light and loaded cars has progressed a considerably more complicated apparatus to attain this end seems inevitable. To add complications to the air brake apparatus already in use upon freight cars seems at the present time to be not only unwarranted, but also extremely undesirable. We find that a number of cases have been brought to the attention of the Westinghouse Air Brake Company in which it was complained that serious difficulty and even danger attended the handling of heavy trains upon heavy grades, and in each such instance careful investigation on the part of the brake company brought out the fact that either the brake gear was not suitably applied to the cars, or that the brake apparatus was not properly cared for or maintained in operative condition. The latter has been found to be the chief cause of trouble. In most instances the trouble has been found to be due to neglect of the apparatus. In all of these cases, however, careful investigation, provided convincing evidence to the railroads that with proper application and care of the air brake apparatus now in use, it is fully capable of meeting all the requirements of service, even under extreme conditions.

The difficulty of applying suitable brake gear is frequently found to be one of the obstacles to securing efficient operation of the airbrake on freight cars. Freight trucks are often so designed that it is almost impossible to hang the brake beams in a manner to secure uniform and efficient service of the apparatus. It has been demonstrated that if freight trucks were designed with sufficient wheel base and in a manner to permit

the use of proper brake hangings, the efficiency of the brakes might be much increased. As freight trucks are now constructed, it is almost impossible to hang the brakes so as to secure anything like a proper efficiency.

Investigation of the condition of brake equipment of cars on many roads indicates that the use of a suitable slack adjuster to maintain the proper piston travel would go far toward remedying that species of neglect which results in the extreme movement of the brake cylinder piston and the consequent inefficiency of the brakes. A satisfactory device of this kind is available and its application is strongly urged.

The inspection and cleaning of brake cylinders and triple valves is, no doubt, receiving far more attention than it has in the past; but it is nevertheless true that there is room for great improvement in this direction. Until the time shall come when the railroad companies are fully alive to the necessity of properly maintaining and caring for the apparatus which they now have upon their freight cars, it is manifest that a further complication of the apparatus to secure a variable braking power, in accordance with the variations of load, would not only be wholly undesirable, but would probably prove to be a source of danger to the safe movement of trains, on account of the much greater proportion of defective brakes that would have to be cut out of service. At any rate, it would seem to be a wise course on the part of the railroads to first demonstrate that with proper application and suitable care of the apparatus they now have, the conditions of service are not safely and satisfactorily met.

GASOLINE AND OIL ENGINES FOR PUMPING STATIONS.

Gasoline engines are specially well adapted to the pumping of water at railroad water stations, and their use is sure to become much more general as the advantages they offer are brought to notice. They are economical in cost of fuel and also in maintenance, when good designs are selected, but their greatest advantages are economy in attention required and the freedom from wastefulness when not running. When the engine is stopped all expense stops, while the cost of fuel required to keep up steam in even a small boiler is not by any means negligible. In passing, it should be noted that a gas engine may also serve to furnish other power, such as the operation of coal chute hoists and the driving of electric-light generators.

The Chicago & Northwestern Railway has a 34-horse power gasoline engine at La Fox, Ill., that is fitted up to run a pump furnishing 2,300 gallons of water per hour to a tank elevated 46 feet above the ground level, and also a 12½ kilowatt generator furnishing light for the yards and buildings in the vicinity. The engine uses two gallons of oil per hour while running both the pump and the generator at their full capacities, and the oil costs five cents per gallon, the cost of fuel being stated to be one-half cent per horse power per hour. There are 55 16-candle power incandescent and five arc lights arranged on separate circuits. The attendance required is stated to be one-half hour per day, but considering the attention that lights require this is probably an underestimate. It is sufficient to say that the engine does not usually require any attention except to start, stop and lubricate it, and this may be done by a man who is engaged in other duties for the greater part of his time.

These engines have been very successful in municipal water-works for handling small additional supplies of water or for use in relieving previously installed steam plants. Several applications of this kind are mentioned by Mr. F. C. Coffin in a paper read a short time ago before the New England Water-Works Association. The first of three plants described was put in to pump an additional supply from driven wells for the Cohasset, Mass., Water Company, and conditions required that the supply was to be obtained at the minimum cost. The engine was guaranteed to develop 13 horse power at the rate

of one pound of oil per horse power per hour, the oil to be 150 degrees test. The test showed a consumption of 1.3 pounds of oil per horse power per hour, including the friction of the pump, and the engine alone developed 15 horse power by a consumption of 0.926 pounds of oil per horse power per hour. This plant lifted water about 160 feet, and it worked 115 days with no attention except to oil it and start it in the morning and stop it at night. During the day the building containing the plant was locked up. Mr. Coffin installed a 20-horse power oil engine with a pump capacity for pumping 350 gallons per minute against a head of 142 feet in the high pressure water system of Winchester, Mass. In a test it showed 11,516,518 foot pounds of work on a consumption of a gallon of oil, and this whole plant, exclusive of building and foundation, cost about \$2,900.

Mr. Coffin's experience indicates that a well designed oil engine plant will pump a million gallons of water one foot high for each gallon of oil consumed. This is at the rate of one pound of oil per horse power per hour and allows a loss of .35 per cent. in the pump. Gasoline engines do a little better than this, both oil and gasoline being cheaper than gas in the following proportion: For pumping one million gallons water one foot high the cost will be:

Oil at 9 cents	Gasoline at 9 cents	Gas at \$1.00
per gallon.	per gallon.	per 1,000 ft.
9 cents.	8.1 cents.	13 cents.

In comparing the cost of installation, attendance, supplies, repairs and fuel for steam and internal combustion engines it was found that for the same work done the annual cost of supplies and repairs was a little more for the compound steam engine, the cost of attendance was at 3 to 8 in favor of the internal combustion engine, and in cost of interest and depreciation the internal combustion engine had an advantage over steam represented by the ratio of 7.5 to 10. These figures were made on a basis that was not intended to favor either type of engine. This outline of the possibilities of the gasoline and oil engine appears to justify the conclusion that railroads can afford to discard many of their present steam pumping plants in favor of the internal combustion engines, but caution should be observed in getting an engine of this type large enough for its work, because if overloaded they will slow down and stop working.

FREIGHT CAR CENTER PLATES.

In considering increased train resistance on curves, the causes therefor, and the resulting sharp wheel flanges, stress has been laid upon the weakness of some bolsters, which allowed contact of side bearings, as the principal factor in the waste of the power of the locomotive, by reason of the friction due to such contact, but it appears that little attention has been given to the same cause for complaint in regard to center plates. That such friction is present, and of such magnitude as to demand a remedy, is well known, and taken in connection with weak bolsters with their accompanying friction of side bearings, we find a condition that must be improved if curve resistance and flange wear are to be reduced. This resistance should be made as low as possible by reducing the friction of these parts, no matter whether they are viewed separately or together, and the question of whether a bolster should be allowed to deflect, and thus have the advantage of light and therefore cheaper construction with its attendant deformation of the superstructure, or whether it should be made stiff enough to carry the load free from the side bearings, and thus make it possible to provide for the friction of the center plates only, does not alter the proposition that the time is come for improving center plates.

In a review of the side-bearing question in our issue of September, 1898, page 306, we suggested that the man who had a good frictionless side-bearing should bring it forward, and at the same time intimated that it is "worth while to

consider whether an anti-friction center plate bearing is not equally important." No other confirmation is necessary than the examination of the center plates under heavy freight cars, which will show but little increase of bearing area over the practice long used on lighter cars. When such inadequate bearing surfaces and the load on them are taken into account, with the surfaces not only dry, but of the roughest character, and also working on an abrasive of grit, it is plain that resistances are at work at the truck that call for a greater expenditure of power at the engine than would exist if this friction could be eliminated, or at least reduced. Any improvement in the condition of the bearing parts would make center plates vastly superior to those now regarded as good enough, and there is no doubt that such improvement, if carried to the extent of machining the surfaces, would pay. There is one course open to all by which an improvement may be effected even with the center plates as they stand with their imperfections, namely, to lubricate them.

The Lake Erie and Western has made a practical test of lubricating rough cast iron center plates, with a resulting total absence of flange wear, but the plates were designed to exclude dust and grit. The Northern Pacific has also recently begun the use of lubricated center plates of cast steel, the upper plate is cast so as to retain the oil placed therein, and rests on a loose liner interposed between the two plates. Provision is made for oiling in both these cases by means of an oil duct cast at the side. These two instances of improved center plates indicate the beginning of a better understanding of a detail that has been badly neglected, and the report of ball-bearing center plates in use on the Sea Board Air Line is still further evidence of the same kind.

The idea sometimes entertained that a freight car must be built in the roughest manner because of its service, is a fallacious one, as has been found in connection with details other than those discussed here. Unnecessary refinement is not advocated for freight car work, but we would like to impress the need of mechanical work on details like center plates. To illustrate the different estimates of the relative value of like work on a locomotive and car, it is a fact that the center bearing of a locomotive is almost invariably machined for the purpose of giving freedom of motion to the truck, and thus preventing any tendency to cut flanges or cause derailment through failure to follow the track properly. While on the other hand, the freight car which should be made to give the same results and by the same means, is left to work out its own salvation with center plates in a condition not considered fit to run on a locomotive. It is not easy to account for this inconsistency on any other ground than failure to attack the problem from a mechanical standpoint.

POWERFUL PASSENGER LOCOMOTIVES FOR FAST TRAINS.

Several roads are getting out designs for locomotives to haul heavy and fast passenger trains, for which unusual power long sustained is required. Among the features from which most is expected are large boilers, large and direct steam passages, easily moving valves, large driving wheels and better methods of getting work out of the steam.

The last of these is the most difficult, and the most noteworthy information that has appeared in this connection recently was given in Prof. Smart's paper before the St. Louis Railway Club in February, 1898, giving results of laboratory tests of a model Vaclain four-cylinder compound locomotive at Purdue University. (See American Engineer, May, 1898, page 163.) The results obtained by Prof. Smart were corroborated before the same club at the November meeting by Mr. S. M. Vaclain, and the two papers should be read by all who are working on this problem. While both of these gentlemen present figures of more favorable steam consumption for

the compound, interest centers in the fact that up to the highest limits of speed attained, the power of this type of locomotive increases in constant ratio with the speed. The diagram, Fig. 1, on page 163 of our May, 1898, issue, shows the horse power lines of the Purdue model locomotive to be straight. Prof. Smart found that instead of a rapid falling off in power, that accompanies increase of speed in ordinary simple engines, the change in the steam distribution in this four-cylinder com-

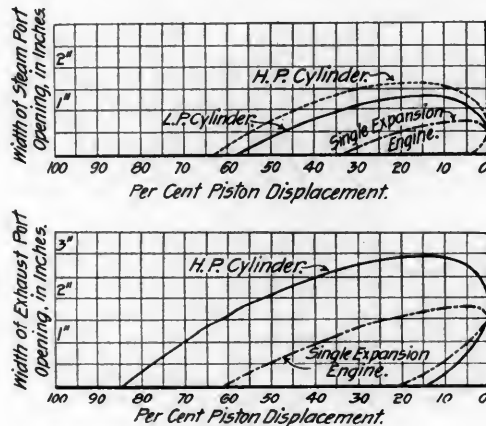


Fig. 1.

pound gave increased horse power and increased economy up to 270 revolutions per minute, the limit of the tests, and the slope of the horse power line tended to show that the power continued to increase for much higher speeds. Whereas the simple laboratory locomotive gave curved lines, showing that the power reached its maximum at about 240 revolutions per minute, and then fell rapidly away.

Mr. Vaclain has added testimony from data taken from

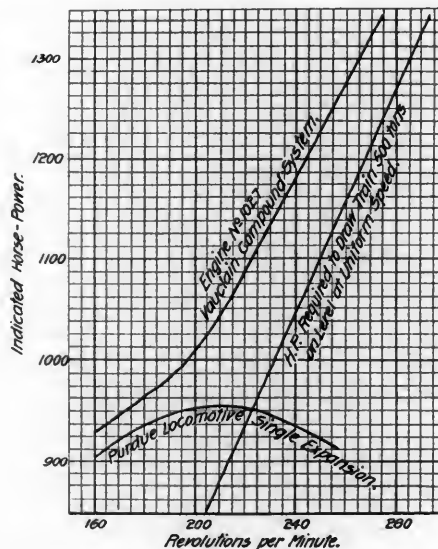


Fig. 2.

the engine of the "Atlantic City Flyer" (American Engineer, December, 1897, page 326, and October, 1898, page 341), and the "Atlantic" type engines of the Chicago, Milwaukee & St. Paul (American Engineer, August, 1896, page 170). He presented diagrams, Fig. 1, of the port openings of this type of compounds compared with simple engines, and attributed the advantage of the compound over the simple engine to the valve motion, and the fact that the steam and exhaust ports of this compound remain open longer than those of the simple engine. The effect of this appears in the absence of back pressure and wire drawing in comparative indicator cards, and the difference between the cards from the compound and simple engines is remarkable. The diagram of the horse power of the Atlantic City engine, above 220 revolutions per minute,

becomes a straight line similar to those secured by Prof. Smart. They indicate that the horse power increased in a direct proportion to the speed until 1,450 horse power at 70 miles per hour was reached, and the power line was straight at that point. This does not accord with the theory of critical speed by Prof. Goss, and while the increase of power in direct ratio with the increase of speed is difficult to comprehend, these records appear to establish this as a fact. It is noteworthy that the increase of power with the increase of speed was greater in the case of the road engine than in the Purdue model. Fig. 2 compares the power of the Atlantic City engine with the Purdue simple engine known as "Schenectady No. 1," and Fig. 3, reproduced

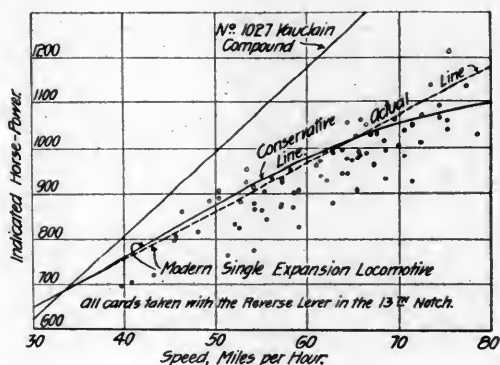


Fig. 3.

from Fig. 18 of Mr. Vaucain's discussion, compares the Atlantic City engine, No. 1027, with "a single expansion engine," and the straight line for this engine was plotted from the actual results, the curved line having been laid down through conservatism and lack of confidence in several of the cards. The divergence of these two straight lines, according to Mr. Vaucain, represents the advantage from compounding. He further states that properly designed valve motion will enable a simple engine to show an increase of horse power in the form of a straight line, and that the line will be straight up to the limit of the endurance of the engine.

Accepting the statements concerning the model and the Atlantic City engine as careful and accurate, to what do they point?

Mr. Vaucain attributes the whole to the compounding, we may say to this particular type of compounding, and chiefly to the superior action of the valve motion. He does not go into details, and after stating a strong case for the compound he does not state why the simple engine cannot be made to equal this performance. It is to be presumed that the simple engine selected for comparison with the compound was comparable with it, but the great importance of the conclusions merits further elaboration. In the case of the laboratory model at Purdue the steam was taken from stationary boilers, which to a certain extent deprives Prof. Smart's results of the advantage of direct comparison with road practice.

Dividing the work up into four cylinders probably has a great deal of influence on the power at high speeds. It permits of using the valve motion more favorably, because of deferring the cut off, and the amount of steam to pass through any one pair of ports is less than with two cylinder engines. A 14 and 20 by 24-inch Vaucain compound cutting off at half stroke will use about 1,800 cubic inches of steam per stroke of one high-pressure cylinder, whereas a simple engine of the same tractive power will use about 2,300 cubic inches to do the same work. This statement is approximate only, but it is sufficient to indicate that less steam passes through the ports of this type than through those of a simple engine to do the same work.

The influence of the boiler power is, however, a vital one in comparing locomotives, and the Atlantic City engine certainly has an advantage in this respect over most passenger engines.

This engine can haul a train weighing 606,500 pounds 55½ miles in 47½ minutes, in regular service, an average speed of 70.08 miles per hour, and the boiler furnishes steam enough to keep the pressure within 3 pounds of 205 pounds per square inch for the entire run. The grate area is over 75 square feet, and the driving wheels are 84¼ inches in diameter, both of which are also favorable to sustained power at high speed.

It is clear that this discussion touches the most important questions of design of heavy and fast passenger locomotives, but they are not solved until the proportion or effect of other features than the cylinders in these excellent results is known.

NOTES.

The torpedo boat "Farragut" in her recent official trial is reported to have made the record of 30.6 knots per hour with 426 revolutions per minute.

Great interest is taken in the Universal Exposition to be held in Paris in 1900 by American manufacturers. Commissioner General Ferdinand W. Peck states that our manufacturers alone have applied for ten times as much space as is available.

"When I visited America in 1884," said Mr. W. H. Preece, of London, in a recent address, "there was only one experimental electric railway line at work, in Cleveland, Ohio. Now there are more miles of line so worked in Cleveland alone than in the whole of the United Kingdom."

Serious damage to rails on the Wabash Railway by hauling a disconnected engine at a speed of about 40 miles per hour is reported in "The Railway and Engineering Review." Ten rails were broken and 772 were so badly surface-bent as to require their removal. The rail weighed 63 lbs. per yard and the driving wheels of the engine were 56 in. in diameter. The road has a rule limiting the speed of disconnected engines to 20 miles per hour.

The subject of hot boxes was accorded interesting discussion at the last two sessions of the Chicago Car Foremen's Association, says the "Railway Master Mechanic." There are various causes for hot boxes, but the trouble is that these causes are not always accurately determined. Mr. J. N. Barr, in addressing the Association at the last meeting, made the excellent suggestion that the better way to adopt in studying the causes of hot boxes would be to systematically examine boxes that are just a little hot, and not wait until everything was so hot and in such a shape as to conceal the initial cause of the trouble.

One of the most interesting features of the Paris Exposition to the railroad man will be the monster relief map of the railways of the United States, showing every railroad, telegraph, telephone and express line, besides the Great Lake steamship lines and transatlantic steamship ports. The gigantic proportions of this map may be imagined when it is stated that more than one-half the world's railroad mileage is in this country. This map is to be made on a scale of one inch to the mile, and to make the proposed exhibit properly at this scale, the map will be 140 feet high and 230 feet long—a surface of 32,200 square feet. The estimated cost of this undertaking is \$100,000.

The importance of the heat treatment of steel was emphasized by Mr. H. V. Wille before the Franklin Institute last month. He had tested a sample which, when judged by the tensile strength, reduction of area, elongation and chemical analysis, would be regarded as the highest grade of material, and, in fact, it passed two inspections on such tests. Notwithstanding the results of these tests, the plate cracked in numerous places between holes when an effort was made to roll it to a 60-inch ring. A test was now cut from the plate, and failed, in an ordinary cold bend; but a second test cut

from the same portion of the plate, when heated to dull cherry and quenched in water, bent flat without signs of distress, proving that a good plate of steel was injured by finishing at an improper temperature. Its tensile strength was 59,200 pounds per square inch, elongation 28 per cent. in 8 inches and reduction of areas 50.2 per cent. The carbon was 0.24; manganese, 0.39; phosphorus, 0.012; sulphur, 0.020, and silicon, 0.02.

The Massachusetts Institute of Technology received over \$968,000 during the year 1898, and, according to the President's annual report, \$400,000 more is expected. The cost of instructing each student, including the expense of the laboratories and shops, is \$330 per year, and the tuition fee is \$200. The deficiency is made up by State and individual gifts. The number of instructors is unusual, the proportion being one to every eight or nine students, and this is not counting the lecturers, who are not permanently connected with the school. The school is comparatively young, and is probably only beginning to receive the support of alumni that forms a large part of the financial assistance of most colleges.

The 8-inch Gatling, one-piece, cast steel gun, the preliminary trial of which at Sandy Hook was noted last month, burst on the firing of the fifteenth charge at a pressure of 36,500 pounds per square inch. This pressure was not far from the maximum recorded for the first five proof shots, the highest being 37,000 pounds from a charge of 142 pounds of Dupont brown prismatic powder. An appropriation of \$40,000 was made by Congress for the construction of this gun, and it was expected to prove that guns may be made in one piece of cast steel at an immense saving over present methods. Dr. Gatling attributes the failure to the over-annealing of the breech of the gun during its manufacture. On page 18 of our January issue we mentioned the process of pouring.

The new White Star liner "Oceanic," the largest ship in the world, was launched Jan. 14 at Belfast, Ireland. In our issue of July, 1847, page 232, the chief features of the ship were described. She has the following dimensions: Length, 705 feet; beam, 68 feet; draft, 27 feet; gross registered tonnage, 17,040; horse power, 28,000; speed, 21 knots. Comfort and regularity are considered as more important than speed and the arrivals of the ship are expected to be as regular as those of the best railroad trains. It is interesting to know that all of the White Star liners have been built by Messrs. Harland & Wolff, of Belfast, and, including the "Oceanic," they have all been built upon honor and without a contract between the owners and the builders. This tribute to the integrity of the firm deserves thoughtful consideration.

That steel increases in strength a few days after the completion of manufacture was shown by a report of a series of tests by Mr. A. A. Stevenson, of the Standard Steel Company, Burnham, Pa., offered in discussion before the Franklin Institute. (See Journal, Franklin Institute, January, 1899.) Mr. Stevenson, in testing specimens from locomotive tires, found the following results from specimens tested at the same speed:

Dimensions.	Elastic limit.	Ultimate strength.	Elongation. Per cent.	Reduction. Per cent.	Remarks.
2 x 0.500	53,490	107,460	15	19.20	Pulled within three days after tire was made.
2 x 0.500	56,037	108,700	16.30	24.30	Ten days later.
2 x 0.500	50,940	99,590	14	22.20	Pulled within three days after tire was made.
2 x 0.500	53,000	103,464	18	27.40	Ten days later.
2 x 0.500	56,037	111,050	10	12.37	Pulled within three days after tire was made.
2 x 0.500	61,130	111,410	15	21.50	Ten days later.
2 x 0.798	70,370	121,250	11	14.01	Pulled five days after tire was made.
2 x 0.798	71,980	121,970	14	17.89	Seven days later.
2 x 0.798	65,080	121,470	11.50	13.55	Seven days after tire was made.
2 x 0.798	64,400	121,160	13	16.30	Fourteen days later.

LOCOMOTIVE DESIGN—THE WORKING STRENGTH OF MATERIALS.

By F. J. Cole, Mechanical Engineer Rogers Locomotive Works.

PARALLEL OR SIDE RODS.

(Concluded from Page 23.)

For resistance to bending the rod should be considered as a column with flat ends. It has hinged or pin-bearing ends, however, against bending in a vertical plane, or in the direction of its depth or greatest side, but when resisting bending horizontally or in the direction of its least width the end bearings are flat.* The strength of a long column depends more upon its resistance to bending than to the crushing strength of the material, and is a function of its elastic rigidity or modulus of elasticity E , the ratio of the length L in inches, the least radius of gyration r , the rigidity function of its cross section, expressed $\frac{L}{r}$, the shape of the end bearings, round,

flat or hinged, and the eccentricity of the load. For a straight column, systematically loaded, supported at its gravity axis, so as to be perfectly free to bend, and for a ratio of $\frac{L}{r}$ sufficiently large, Euler's formula will give the strength. This formula is:

$$P = \left(\frac{1}{r} \right)^2 \frac{\pi^2 E}{L^2}$$

where P = the ultimate strength of the column in lbs. per square inch.

E = modulus of elasticity in lbs. per square inch.

L = length of column between the pivot bearings, in inches.

r = least radius of gyration of the cross section of the column, in inches.

This is only correct for very long, perfect columns centrally loaded, where $\frac{L}{r}$ exceeds 200 and for pivoted ends. For flat or hinged ends a suitable coefficient should be introduced. The formulae for these conditions may be assumed as follows:

$$\text{For flat ends } P = \frac{25 E}{\left(\frac{L}{r} \right)^2}$$

$$\text{For hinged ends } P = \frac{16 E}{\left(\frac{L}{r} \right)^2}$$

The parabolic column formulæ for ordinary lengths, say, of less than a ratio of $\frac{1}{r}$ 200, given by Prof. J. B. Johnson

in "Materials of Construction," appear to fit the tests of columns better, and are more suitable for our purpose than any others. The two which will be considered are:

Ultimate strength in pounds per square inch—
For wrought-iron columns, flat ends,

$$\text{For wrought iron columns, flat ends } \left(\frac{1}{r} < 210 \right)$$

$$P = 34,000 - .43 \left(\frac{1}{r} \right)^2$$

$$\text{For mild steel columns, flat ends } \left(\frac{1}{r} < 190 \right)$$

$$P = 42,000 - .62 \left(\frac{1}{r} \right)^2$$

Fig. 6 shows a diagram of the curves derived from these formulæ, also the curve for the Euler formula, adapted to col-

* See Johnson's Materials of Construction and Modern Framed Structures.

umns with flat ends. This shows graphically why the Euler formula should not be used for columns of ordinary length, which has sometimes been attempted upon the idea that it was applicable to all lengths of columns. For the rod under

consideration $\frac{l}{r} = \frac{100}{.598} = 167$. The ultimate destructive pres-

sure per square inch = $P = 42,000 - .62 \left(\frac{l}{r}\right)^2 = 24,710$ pounds.

The force transmitted through the rod is 25,900, and the sectional area 6.56. The ultimate strength to resist pressure is $24,710 \times 6.56 = 162,097$ pounds.

It is safe to assume that the maximum stress due to the

parallel rods of hammered wrought-iron, Fig. 8, section in center $1\frac{1}{2}$ by 5 inches, the rods frequently break.

The maximum fiber stress due to the centrifugal force alone at 70 miles per hour (a speed which these engines frequently attain) is:

Revolutions per second, 5.68.

Velocity in feet per second = $5.68 \times 6.28 = 35.67$.

Weight of rod per foot = 31.25 (ham. iron).

Weight of rod (except ends) = $31.25 \times 100 = 260$ lbs.

$$F = \frac{260 \times 35.67^2}{32} = 10337$$

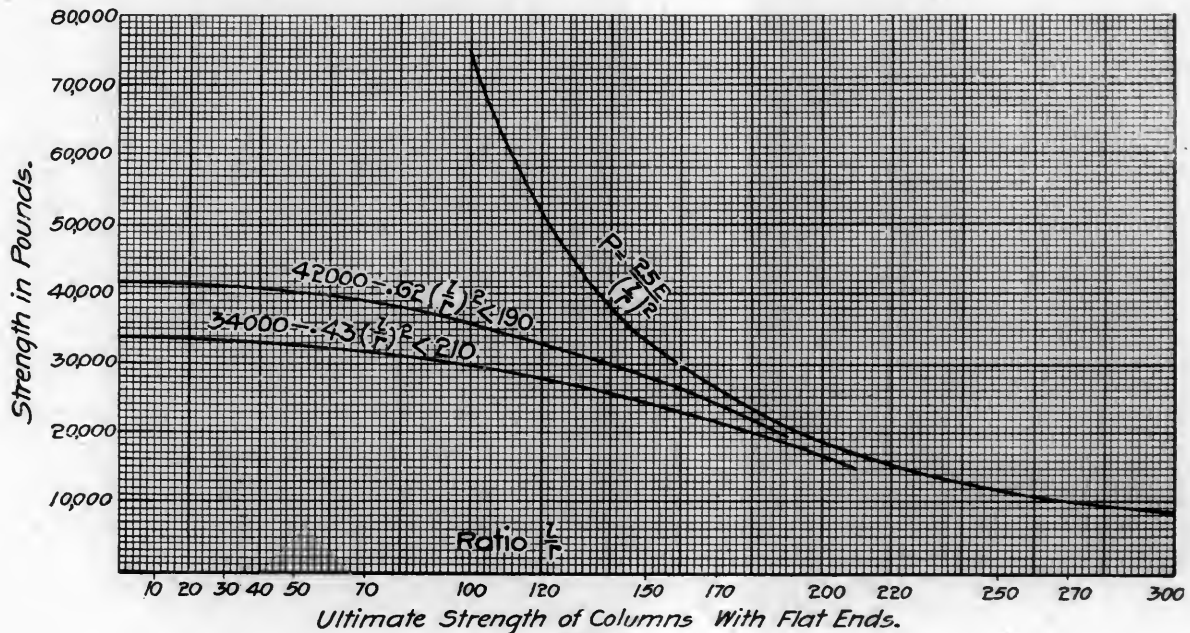


Fig. 6.

thrust of the piston, either in tension or compression (the latter force tending to bend or buckle the rod in the direction of its least width), will not occur in combination with the maximum stress due to the centrifugal force. The latter is at zero for bending in a vertical plane, when the piston is at either end of the stroke, gradually increasing until the crank has moved 90 degrees, then decreasing until it becomes zero again at the other end of the cylinder, where it is a force acting directly in line with the axis of the rod.

The indicator diagram, Fig. 7, shows approximately the steam distribution of a locomotive running at 60 or 70 miles per hour, with a 68 to 72-inch diameter driving wheel.

For convenience, the path of the crank is also shown. The

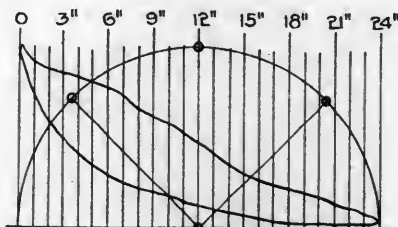


Fig. 7.

steam pressure, it will be observed, only approaches the maximum at the beginning of the stroke, and at half stroke less than 50 per cent. of the boiler pressure. It is practically impossible for the maximum piston thrust to be prolonged until half stroke, when running at high speeds.

With the following conditions: 19x24 inch cylinders, 69 inch diameter driving wheels, American 8-wheel type, 100-inch centers between wheels, 150 pounds boiler pressure and

$$S = \frac{10337 \times 100}{8 \times 7.81} = 16,540 \text{ lbs.}$$

The ultimate strength as a column to resist buckling is as follows: Area 9.38, moment of inertia 2.746 (least side), least radius of gyration .541, ratio $\frac{l}{r} = 185$.

The ultimate strength = $34,000 - .43 \left(\frac{l}{r}\right)^2 = 19,275 \times 9.38 = 180,800$ lbs. The force transmitted by the rod = $19^2 .7854 \times 150 = 21,225$ lbs.

The I-section rod shown in Fig. 9 has been used for a number of years without any known fractures for high speed 8-

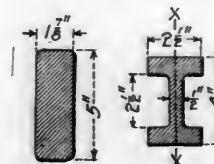


Fig. 8. Fig. 9.

wheel American type passenger engines having cylinders 20x24 inches, material steel, with a tensile strength of from 70,000 to 80,000 lbs., drivers 78-inch diameter, steam pressure 160 lbs., length between centers 90 inches, moment of inertia (axis perpendicular to web) 10.728, section modulus $\frac{I}{0.5h} = 5.364$, weight of section per foot 17 lbs., weight of rod except

ends $17 \times 7.5 = 127$ lbs. Eighty miles per hour $= 5.747$ revolutions per second, the velocity per second $= 5.747 \times 6.28 = 36.09$, $F = 5,162$ lbs., $S = 10,830$ lbs. fiber stress due to centrifugal force. The normal force transmitted through the rod to the rear wheel due to the piston thrust is: $\frac{20^2 \times .7854 \times 160}{2}$

$= 25,120$ lbs.

Its ultimate strength as a column with flat ends to resist buckling is:

Least radius of gyration $= .563$. Area of section $= 5$. $P = 42,000 - .62 \left(\frac{1}{r} \right)^2 = 26,130 \times 5 = 130,650$ lbs. Ratio of force transmitted to ultimate strength in compression, $\frac{130,650}{25,120} =$

5.2. And for tension, $\frac{25,120}{5} = 5,025$ stress per square inch,

ratio of tensile stress to ultimate $= \frac{5,025}{75,000} = 14.9$. This sec-

tion is lighter than usual, representing probably the minimum weight and highest stress which should be used for this purpose. As a matter of fact, later engines of this type were built with rods of heavier section, not, however, because they had broken or cracked in service, but owing to their being much lighter and smaller in section than other rods on engines of this size in general use it was feared that they might break, especially as the engines were hauling some of the fastest trains in this country.

Two examples of freight engines with plain rectangular rods of hammered iron are given below. There is nothing peculiar about them; no breakages in the bodies have occurred in seven or eight years; they merely represent average and ordinary conditions. The speed in both cases is taken at 45 miles per hour as a maximum. The conditions for the first are: Consolidation type cylinders, 21×26 in.; steam pressure, 165 lbs.; drivers, 50 in. diameter; piston thrust, 57,090 lbs.;

force transmitted by back section of rod $= \frac{57,090}{4} = 14,270$ lbs.; sectional area, $1\frac{3}{4} \times 4$ in. plain rectangular; weight per foot, 23.8 lbs.; weight of rod (exclusive of ends) $=$

$$\frac{23.8 \times 61.5}{12} = 122 \text{ lbs.}$$

area 7 square in.; modulus of section, 4.67; length in in., $61\frac{1}{2}$; least radius of gyration, .505; ratio $\frac{1}{r} = 129$; ultimate strength to resist bucking:

$$34,000 - .43 \left(\frac{1}{r} \right)^2 = 27,500 \text{ lbs.} \times 7 = 192,500.$$

Stress due to centrifugal force:

Velocity in feet per sec. $= 34.3$

$$F = \frac{34.3^2 \times 122}{1.083 \times 32} = 4,136 \text{ lbs.}$$

$$S = \frac{4136 \times 61.5}{8 \times 4.67} = 6,808 \text{ lbs.}$$

The conditions for the second type are: Ten-wheeler; cylinders, 19×26 in.; steam pressure, 165 lbs.; piston thrust, 46,695; force transmitted through the back section of rod, 15,565 lbs.; section, $1\frac{3}{4} \times 4$ in., plain rectangular area, 7 square in.; length, 75 in.; drivers, 50 in. diameter; ratio, $\frac{1}{r} = 148$; ultimate strength to resist bucking:

$$34,000 - .43 \left(\frac{1}{r} \right)^2 = 24,582 \times 7 = 172,074 \text{ lbs.}$$

Stress due to centrifugal force:

Velocity in feet per sec. $= 34.3$

$$F = \frac{34.3^2 \times 149}{32} = 5,478 \text{ lbs.}$$

$$S = \frac{5,478 \times 75}{8 \times 4.67} = 10,990 \text{ lbs.}$$

CONCLUSIONS.

The conclusions are briefly summarized as follows:

The extreme fiber stress in long rods caused by centrifugal force can be safely taken at 11,000 lbs. for steel and 9,000 lbs. for wrought iron per square inch.

The stress due to the direct push and pull of the piston should not exceed 5,000 lbs. per square inch for steel and 4,000 lbs. for wrought iron. This refers more particularly to I sections, as the plain rectangular sections have areas so much larger that the stresses due to the centrifugal force and buckling as a column become the limiting factors.

The ultimate resistance to buckling should not be less than five times the normal working load transmitted through the rod; that is, if the force conveyed by the rod is 30,000 lbs. it should be so proportioned that it would not fail by bending or buckling at less than 150,000 lbs.

THE SOUTH UNION STATION, BOSTON.

In our February, 1897, issue, we gave an account of a projected terminal station for roads entering Boston on the south side, together with a perspective view of the structure, and a general plan of the track and loop scheme as they would appear when completed. After the lapse of nearly two years this handsome terminal is now ready and open for business. It was opened on the first of January to the Old Colony and the New England trains only, as the Boston & Providence and the Boston & Albany have not yet made the necessary track connections.

This terminal station, the largest in the world, is bounded on three sides by Cove street, Federal street, Sumner street and Dorchester avenue. It is on ground once occupied by the New England station. Opposite the end of Federal street is situated the main entrance. The building extends from this entrance south 792 feet, and east on Sumner street 672 feet. As seen from Federal street, the central part of the building is a five-story structure, the first story of which is devoted to station purposes, and the remainder to office uses. In the central curved part, 228 feet long, two stories high, there are three grand entrance arches, the upper stories forming a colonnade, the columns of which are 52 inches in diameter and 42 feet high. Above the colonnade the entablature and parapet, broken by the small projecting pediment, carry the facade to a height of 105 feet from the sidewalk. Above all, and at the center, is the clock, with a dial of 12 feet in diameter, which is surmounted by an eagle. All of the curved portion of the front is built of Stony Creek granite, and nearly all of the remaining portion is of the same stone, but on each side of the colonnade the stone work is relieved by large, dark-buff mottled bricks.

The total length of the five-story front is 875 feet; that of the two-story portion, along Atlantic avenue, 356 feet; of the two-story part on Sumner street, 234 feet. On Dorchester avenue the building continues 725 feet, two stories high. The total frontage on three streets is 2,190 feet. Entering at the main entrance, there are no steps to surmount, but a clear passage way, with an easy rise of about 3 feet in 100, leading into the great midway, lying across the ends of the stub tracks. Near the center of the midway are stairways leading to the lower floors, and at convenient locations are the newspaper and fruit booths. Opening from the midway at the right is the parcel room. At the left are the lavatories, telegraph and telephone offices, and a ticket office with 11 sales windows toward the midway, besides 16 openings into the waiting room.

The waiting room has a width of 65 feet, length of 225 feet, and height of $28\frac{1}{2}$ feet. The women's room is located off from a corner of the waiting room, and is 34×44 feet, elegantly furnished with rockers, easy chairs and lounges. At the corner of the lunch room is the stairs and elevator to the dining room, on the second floor. The floors above the first story are used for offices and employees. Conductors and trainmen have quarters on the Dorchester avenue side, and the remainder of the second story is devoted to the use of the Boston Terminal Company. The entire third story is occupied by the offices of the Boston &

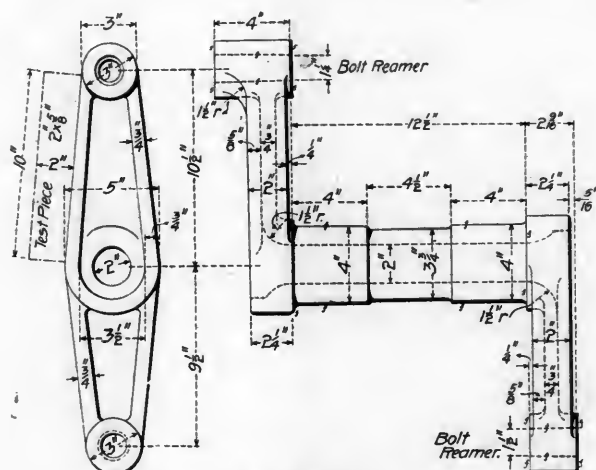
Albany, and the fourth and fifth stories are assigned to the New York, New Haven and Hartford Railroad.

The power plant contains 10 large boilers, two economizers and 1,500 horse-power of Westinghouse compound engines, driving four Westinghouse multipolar dynamos, which are direct connected, while the total horse-power is about 2,000, with ample provision in space for a possible increase of about 50 per cent. The description of the station plans, previously referred to, give further details of this magnificent piece of work.

CAST STEEL ROCKER SHAFT.

By the courtesy of Mr. E. E. Davis, Assistant Superintendent of Motive Power of the Philadelphia & Reading Railway, we illustrate one of the patterns of cast steel rock shafts now used on that road. In this shaft, which was designed by Mr. H. H. Vaughn while mechanical engineer of the road, an attempt has been made to distribute the metal so as to effect the greatest possible economy in material, an object of importance when it costs 4 cents per pound, and also to avoid any variation in the thickness of the casting likely to introduce local weakness. Lightness and strength are evident in the coring of the body and form of the arms which are of I-section.

The cast steel shaft requires very little labor in the machine shop, the only finish on it being at the ends of the bearing, at



Cast Steel Rockers.
Philadelphia & Reading Ry.

the pin holes and the faces of the pin bases. Owing to its lightness, the cost of material is even less than for a wrought iron shaft for the same duty. The costs per pair being as follows:

Cast steel shafts:	
Material, at 4.5c.....	\$7.46
Machine shop, labor.....	3.26
Total.....	\$10.72

These figures are based on actual casts, not estimated in any particular, and so far the test of service has shown the steel shaft to be perfectly satisfactory.

SIR W. H. WHITE ON ENGINEERING EDUCATION.

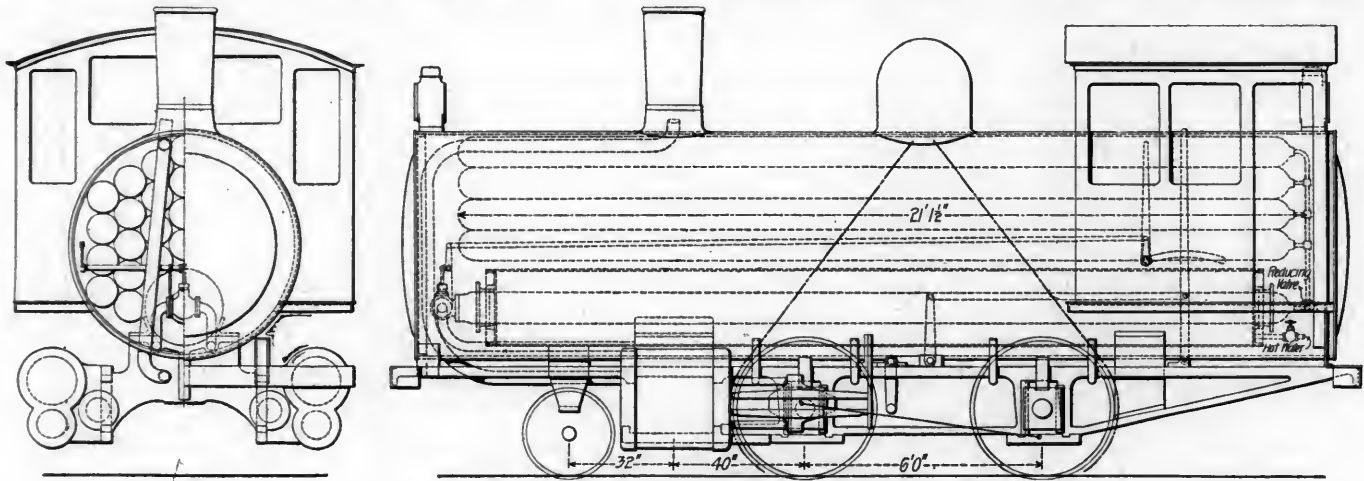
A meeting of the Institution of Junior Engineers, held in London in October, was addressed by the President-elect, Sir W. H. White, Assistant Controller of the Navy and Director of Naval Construction, on the subject of an engineering education. Among other things, he said the past century had witnessed a wonderful growth and development of civil engineering. Scientific method was becoming more and more established in engineering practice and in experimental research. There was no exclusion of engineers from the ranks of scientific men. And there were numerous instances of men distinguished no less as men of science than as engineers.

Having enforced the importance of "communion and fellowship" between all branches of engineering, he desired to record

his equally strong conviction that for the "average man" an early specialization of practice was advantageous and generally led to greater success. Probably for many of the members of the institution there had been no alternative, and it had been necessary to undertake work in some department of engineering at an early period. Provided the preliminary education had been satisfactory there was not, in his judgment, any reason for regret if that necessity had arisen. It had been his fortune to be constantly asked what course of training he would recommend for youths intended to become engineers. His advice had always been the same, and it was based on personal experience and extensive observation. Practical training in the workshop, factory, ship yard or other engineering establishment was, he considered best begun when a lad was fresh from school. "Roughing it" then came easy, observation was quick, while the facility for acquiring handicrafts and manual dexterity was greatest. Familiarity with the habits and modes of thought of workmen was readily gained also, and was a valuable acquisition. During the period of practical training it was most desirable that scholastic knowledge should be maintained or extended. Unfortunately, this was often neglected, and the loss was serious. In many cases arrangements could be made by which boys need not be subjected to such extreme physical exertion as would prevent evening study, and in all great industrial centres suitable evening classes were now established in which instruction could be obtained. If this programme were carried out, a young man finished his practical course without loss of educational knowledge, and if he had the means and capacity he was well prepared for entry into a technical college at an age which permitted him to obtain the full benefit of theoretical training and laboratory work. With ability and energy commensurate to the task a student thus prepared, and bringing with him considerable practical experience, ought to reap the greatest advantage from the higher course of study, and to be ready for actual work when it was completed. His observation and experience as student and professor convinced him that many youths entered technical colleges who, from want of preliminary education or of ability, could never hope to benefit much, if at all. It would be a kindness in such cases if entry were guarded by such preliminary tests and inquiries as would prevent waste of time and permit other and more suitable training to be undergone. Perhaps the ideal system of training was that which permitted an engineering pupil to continue his scholastic training side by side with the preliminary practical experience, as the medical student attached to a hospital did. Selected men, having proved their capacity, could then proceed to a course of higher technical training without losing all contact with practical work. The latter condition could be met by arranging suitable intervals when students would suspend their studies of theory and go out to the scenes of engineering operations, where they could compare the lessons learned in the study and laboratory with actual procedure in carrying on work. Opinions differed widely respecting the system of "premium apprentices." He had his own opinion, but would not express it. On one point there would probably be general agreement. It would be a distinct advantage if young men of that class, who as a rule had the necessary preliminary education and possessed the means, could combine theoretical training with their period of employment in the office, workshop or ship yard. This would appear to be quite feasible and unobjectionable. While he was convinced of the desirability for most men to decide early on the kind of engineering work they desired to do, and thoroughly to qualify for its performance on both the scientific and practical sides, he was aware that many authorities took a different view. Nor did he suppose that there were not exceptions to the rule he suggested. It was intended for the average man, and not for the genius, who was outside all rules. Most of them could lay no claim to genius; and before long they learned to recognize their limitations. They could, however, all display that form of genius which consisted in the capacity for taking pains and doing their best. Educational facilities were fortunately more ample than they had ever been, as well as more within the reach of modest means. No one could now complain of lack of opportunity for perfecting his equipment as an engineer. The existence of that institution was an evidence of the changed conditions under which engineering work had to be done. Its educational influence was doubtless considerable. Let them hope that it might long continue to flourish and be increasingly useful to junior engineers.

VAUCLAIN'S COMPRESSED AIR LOCOMOTIVES WITH HEATER.

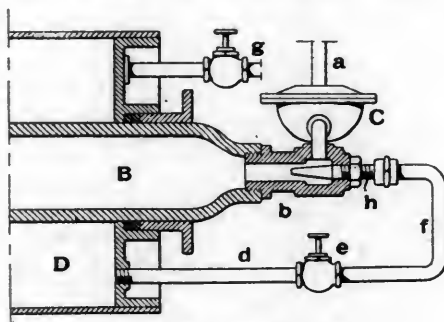
The Baldwin Locomotive Works, in June, 1897, built a compound four-coupled compressed-air locomotive, of the mining type, for the Philadelphia & Reading Coal & Iron Company for use in their Alaska Colliery, and its success led to the order-



Vauclain's Compressed Air Locomotive.

ing of three more of the same kind. This firm is prepared to build compressed-air locomotives, either single expansion or compound, to suit any requirement of service for which compressed air is suitable, and a recent improvement in design in the form of a heater has been developed and patented by Mr. S. M. Vauclain, although this has not yet been applied to an actual locomotive.

This is shown in the engravings as applied to a locomotive having its storage tanks in the form of tubes. These tubes



Showing Heater Piping.

are connected by pipes at the back end and to an auxiliary reservoir B by the pipe A. The air for the cylinders is taken from the front end of the reservoir B. The reservoir is surrounded by a hot-water drum D, which is filled through the pipe G. The pipe D connects with a nozzle H to inject a spray of hot water into the reservoir B to assist in heating the air and to lubricate the cylinders. A reducing valve C is placed in the pipe connection between the storage reservoir and the auxiliary reservoir B.

THE MASTER MECHANICS' STAYBOLT COMMITTEE.

If the committee, comprising Messrs. Lawes, Vauclain and Wilson, on the best method of applying staybolts in locomotive boilers receives answers to their circular of inquiry as painstaking and thorough in their scope as are the questions formulated, they will have information that will furnish the groundwork for one of the most valuable documents ever presented to the association. They have covered the staybolt matter most completely in a series of 18 questions, which embrace

every kind and stage of manipulation, from the rough bar to the finished bolt and its manner of application, together with the way in which the holes are prepared to receive the bolts. With special reference to fit alone there are two clauses in this circular that it is hoped will have the attention their importance demands. First, "Do you consider a lead screw attachment to a staybolt screw-cutting machine essential in producing good staybolts?" The object of this question is evi-

dently to determine the relative value of this refinement in screw cutting as practiced on staybolts, over the old and more crude output of the ordinary dies. We believe there cannot be two opinions in this matter, since a true and constant pitch of thread is an imperative requirement in avoiding initial stress on bolts or sheets. Having a direct bearing on this phase of the subject is another which reads: "Have you any special kind of taps for tapping staybolt holes?" What are the advantages of such taps as compared with the usual form of tap?

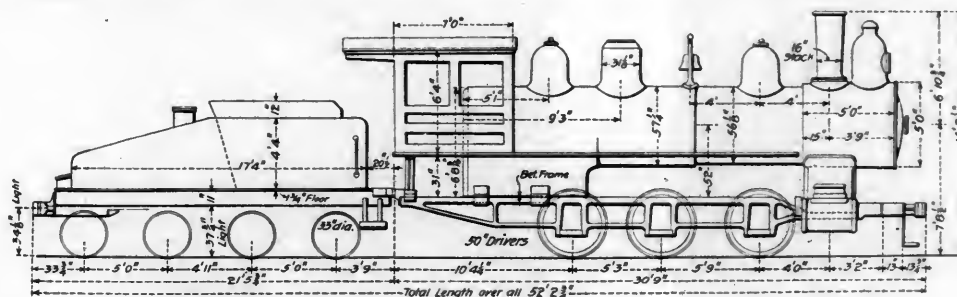
A very close relation (that should, but does not often, exist) between a staybolt tap and the finished bolt is one of the things too often taken for granted, with the result of producing a stress on the bolt before performing its office. This is brought about by variation in pitch of the thread, and a bolt when applied under these circumstances must be made small and thus sacrifice the fit, in order to pass through both sheets. The importance of attention to the accuracy of pitch is as vital to success in one case as the other, and harmony in this particular between staybolts and their taps, we think is one of the essentials to good staybolt work. The error in pitch of threads cut by the Jones & Lamson system is reduced to working limits and is practically constant, while that existing in taps comes from two sources, one from lead screw error on the lathe cutting the thread, and the other from shrinkage due to hardening. If the former error is plus, it will tend to neutralize the latter, but if minus then they become cumulative and the tap is unfit to use. These errors of pitch are not as well recognized as they should be, and we believe on this account the staybolt question would be simplified greatly by an earnest effort looking to their elimination in all railroad shops, as we know it to be done in the shrinkage of the tap, and thus have it of correct pitch as in the Northern Pacific shops at Brainard, Minn. In this case, all errors of lead screw are overcome by means of an auxiliary device on the lathe threading a tap, by which the carriage and with it the thread tool are retarded or accelerated uniformly over the threaded portion, and by its use the thread may therefore be cut so as to be sufficiently short to overcome the shrinkage of the tap and thus have the pitch more nearly correct after hardening.

Ship draftsmen are wanted for a number of government positions at various places and civil service examinations will be held February 7, 8, 9 and 10. Examinations will be held in every city where the civil service commission has a Board of Examiners. Applicants must write or telegraph the Commission at Washington, D. C., in time for shipment of examination papers. Applicants must be 20 years of age or over.

NEW SWITCHING LOCOMOTIVES.

Chicago, Milwaukee & St. Paul Railway.

The accompanying engraving illustrates the design of new switching locomotives recently built by the Chicago, Milwaukee & St. Paul Railway. These engines are known as Class F. They weigh 103,000 pounds on drivers and the total weight in working order is 158,000 pounds, the weight of the tender being 55,000 pounds. The firebox is on top of the frames and the boiler is high, giving the enginemen the advantage of



New Switching Locomotive—C., M. & St. P. Ry.

elevated positions for watching their work. The following are the chief dimensions of the engines:

Boiler pressure.....	180 pounds
" material.....	9-10 inch steel
Firebox.....	1/2-inch steel
" length of.....	6 feet 6 inches
" width of.....	3 feet 5 inches
" depth of.....	5 feet 2 3/4 inches
Staying.....	radial
Flues.....	2-inch, 12 feet 10 inches long; number, 178
Heating surface, flues.....	1,180 square feet
" firebox.....	132 square feet
" total.....	1,312 square feet
Grate area.....	22 square feet
Steam ports.....	17 1/2 by 1 1/2 inches
Exhaust.....	17 1/2 by 2 1/2 inches
Bridge.....	1 1/2 inches
Valve travel.....	5 1/2 inches
" outside lap.....	3/4 inch
" inside.....	1-32 inch
Valve, mid-gear travel.....	27-16 inches
" cut-off, full gear.....	22 inches
Link radius.....	2 feet 10 3/4 inches
Cylinders, size of.....	18 x 24 inches
Driving journals.....	7 1/2 by 1 1/2 inches
Crank pin, front.....	4 by 3 1/2 inches
" main.....	5 by 4 1/2 inches
" rear.....	4 by 3 1/2 inches
Crosshead pin.....	3 by 3 inches
Capacity of tank for water.....	2,900 gallons
" tender for coal.....	4 tons

STUPAKOFF'S COMPAROMETER.

This is an instrument for the comparison and determination of standard dimensions, numbers of standard gauges, and various correlative properties of objects depending on their dimensions. It is made of tool steel, with the working edges hardened and ground, and contains a micrometer caliper, of English and metric divisions, with various current gauges for wire, plate drills, etc., and gives the weights for round and sheet metals, the number of threads per inch for standard machine screws, and suitable tap drills therefor, besides furnishing the means for comparing any or all of these data with the least possible liability of error.

The mechanical principle involved in the instrument is that of a plane spiral base, combined with a radius vector, movable around its pole. Any movement of this radius vector causes some fixed point on it to recede from or advance toward the spiral. The rate of such recession or advancement is in direct proportion to the arc traversed, and this holds for regular Archimidean spirals of any pitch. The metric circle gives direct readings from zero to 12.7 millimeters, in hundredths of a millimeter, and divisions on the inside of the smallest circle gives relative values in sixty-fourths of an inch.

The comparometer is intended as a time saver in the transposition of values from a given base, its scope being plainly conveyed in the name, "New Universal Gauge and Spirametric Micrometer." The pamphlet describing its uses is issued by the Vulcan Manufacturing Company, Limited, Pittsburg, Pa.

INSPECTION OF WATCHES.

It seems to have been the practice for employees of the Illinois Central to have their watches regulated by others than the inspectors employed by the company for that service, a procedure likely to lead to complications if permitted to continue, and this has brought out a circular from General Superintendent Sullivan in which he said: "As any standard watch purchased from an authorized inspector, which fails to run within a variation of thirty seconds a week, will be redeemed by the inspector, also by the manufacturer, without expense to the owner, there is no object to be gained in attempting to evade

the inspection requirements. Any employee having a watch whose performance is inferior to the standard required, and who attempts by unauthorized regulation to impose upon the inspectors, practices a deception upon the management of the road; it is, therefore, required that hereafter conductors and other trainmen, engineers and firemen shall not attempt to regulate their watches themselves, nor permit them to be regulated by any other person than the authorized inspectors. Failure to comply with these requirements will be considered cause for dismissal from the service."

The Atchison, Topeka and Santa Fe have just taken up a new system of watch inspection, and placed a rule in effect January 1 which provides for a weekly record of all watches within the jurisdiction of the watch inspector. A quarterly inspection has been substituted for the monthly inspection, and trainmen will still be required to sign the daily register. Cards for watch records bearing the name, occupation and address of the owner of the watch, and the name of the movement and the number, have been issued to those interested. On these cards the number of seconds fast or slow, showing the rate at which the watch runs, is recorded, and when the watch is set or regulated by the inspector an entry to that effect is made by him. Once a week a local inspector notes the condition of the watch with reference to accuracy. The cards are sent to the trainmaster on the first of each month.

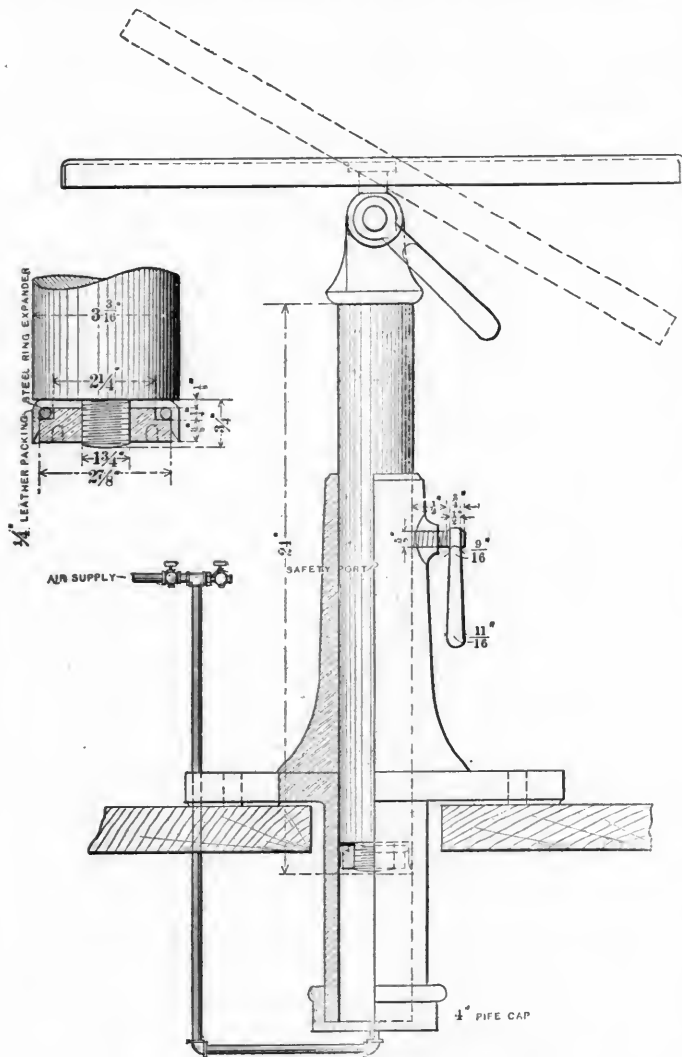
J. PIERPONT MORGAN'S NEW YACHT.

The "Corsair," Mr. J. Pierpont Morgan's new steam yacht and the third of that name to be built for him, was successfully launched at Newburg, New York, December 12. This vessel replaces the "Gloucester" that gave such a good account of herself before Santiago. She was sold to the Government and refitted as an auxiliary during the war with Spain.

The "Corsair" is built entirely of steel, with plates worked in flush above the water line. Her interior arrangements consist of ten staterooms, a library, six bathrooms and a dining saloon on the lower deck. On the main deck, arrangements have been made for a deck saloon, galley, chartroom and deck stateroom with officers' and crew's quarters forward, while the boxes, storerooms, &c., are arranged in the forward hold. Her principal dimensions as designed by Webb are: 302 feet over all, 252 feet on the water line, 33 feet 3 inches extreme beam, 20 feet 6 inches depth of hold, and 14 feet 6 inches draught. She will be equipped with two triple expansion engines, and steam will be furnished by two double-end Scotch boilers. The craft will also have a complete electric plant in duplicate for lighting and other purposes. She will carry three launches, one lifeboat, one gig and one cutter on davits. The Fletchers of Hoboken will build the machinery. Her deckhouses are of galvanized iron and will be covered inside and out with mahogany trimmings, and waterways and rails of teak.

AIR PUMP REPAIR TABLE WITH PNEUMATIC LIFT.

The weight of an air brake pump is such as to render it an awkward piece of work to handle in the shop by one man, and the novel device shown in this engraving was designed and built by Mr. H. S. Bryan, Master Mechanic of the Duluth & Iron Range Railroad, for the purpose of saving expense and labor in refitting and repairing. The pump is bolted to a flat cast-iron table, 19x26 inches in size, by means of two $3\frac{1}{4}$ x9-inch slots cored through it. The table is held on trunnions, on which it may be tipped to any desired angle, and held there by the set screw. The trunnions are carried on a fork, which is forged on the top end of a piston rod, 3 3-16 inches diameter by 24 inches long, fitting in a pneumatic cylinder that forms



Byran's Air Pump Repair Table.

the support of the table. The cylinder has four legs, whereby it is bolted to the shop floor, and its lower end projects about 10 inches below the floor, where it is covered by a 4-inch pipe cap, through which the air pipe communicates. The piston packing is of leather, with a steel ring expander, as shown in the detail view at the left. The air pressure is controlled by two globe valves, and when the table with the pump upon it is raised to the required height, it may be clamped in position by means of the set screw, shown at the right. Safety ports are drilled near the top of the cylinder to prevent raising the piston too high. The table may be tipped into a vertical position, because of the offset of the trunnions below the level of the table. We are indebted to Mr. Bryan for the drawing, and he states that the device is not patented.

THE FIREPROOFING OF WOOD.

That everything on board ship that is not necessarily combustible can be made fireproof, is the opinion of C. J. Hexamer, Ph. D., expressed in an interesting paper read before the Franklin Institute, Nov. 16. The author had given the subject a great deal of study since 1882, and he now recommended a process, using water glass, and said: "I might state that for ordinary purposes a block of wood can be made fire resisting by repeatedly soaking it in a water glass solution, and, when dry, coating it with a mixture of the liquid and cement."

The fireproofing process was to use only well seasoned, thoroughly kiln dried lumber, and to impregnate, if possible, only the finished articles. The wood is placed in a strong metal chamber, closed hermetically, and jacketed with steam, but no steam should be allowed inside the chamber. The moisture is driven out by long continued heating at a little above the boiling point of water. The next step is to exhaust the air, and when the air has been removed from the wood a solution of water glass is sprayed upon the wood. Then a pressure of about 10 atmospheres is applied and kept up for 3 hours, to drive the water glass into the wood. Success depends largely upon the thoroughness of removal of the moisture, sap and air from the wood before impregnation.

Insoluble silica is then precipitated in the wood from the water glass by a solution of ammonium chloride, a very cheap substance, which gave excellent results. It produces in the very fibers of the wood "a gelatinous precipitate of silica; salt, which is readily removed from parts near the surface by soaking in water, tending to preserve the wood in the interior; and ammonia gas, which goes off of itself."

By using strong solutions the process gave specimens of petrification. The author says:

"It will probably be urged that my process is expensive; but in a case like this expense is not a factor. We cannot afford to take the risk of not having everything possible about a man-of-war—or, for that matter, of any ship—fire-proof, when upon that fact may depend a victory or a defeat of our navy. Nor is the expense as great as it at first appears; for the Government should attend to this work itself, and not leave it to contractors. In point of fact, I believe it will be found that the only considerable outlay necessary would be the first cost of the large air-tight receptacles."

ECONOMICAL FORGING FURNACES.

A report to the Master Blacksmith's Association by a committee of which Mr. D. Uren was chairman, contains recommendations for constructing reverberatory furnaces, with a view of economical use of fuel, and the recommendation with regard to complete combustion and the admission of air over the fire is applicable to many other kinds of furnaces, particularly the fireboxes of locomotives. The recommendations, in part, follow:

"We recommend a furnace for general use of sufficient capacity to receive 10 or 12 160-pound or 200-pound piles of scrap iron with two doors properly swung for convenience in opening; furnace hearth to be 4 feet wide, 7 feet 6 inches long, inclined from the bridge wall to the entrance of the flue 4 inches, for the purpose of giving easy flow of the slag to the slag outlet; bridge wall about 14 inches high from the hearth; 25 inches between hearth and roof; combustion chamber 4 x 3 feet; grate bars about 10 inches below the hearth. This gives an area of 1,728 square inches. The furnace is operated with a forced blast under the grate bars. For the purpose of producing more perfect combustion an auxiliary blast pipe is placed across the front end of the furnace. From this pipe branch pipes 1 inch in diameter leading into the combustion chamber, so as to permit the air to pass in half way between the bridge wall and roof, are distributed the full length of the cross-section of the furnace.

"The main pipe is provided with valves, and, if judiciously operated, will greatly assist in producing more perfect combustion. Particularly when the furnace is charged with new coal it requires more oxygen to produce perfect combustion than after the gases have been partially liberated from the coal, consequently this blast should be partly closed after most of the smoke has been consumed.

"The furnace above described is sufficient for all requirements in the ordinary railroad shop.

"This furnace will not be economical regarding fuel for small work, but these are conditions that cannot be avoided. In many cases the heat of the furnaces can be utilized for forming small work after the day's work of forging or scrapping is done. By this means it can be made economical for small work. In furnaces that are constructed for special purposes, such as axle-making or heating for the rolling mill, the proportions as described above should be carried out regarding the hearth and combustion chamber, grate area, etc."

ENLARGED WHEEL FITS FOR DRIVING AXLES.

We have had occasion in recent issues to notice improvements in the design of locomotive details, and prominent among these were crank pins and axles, two parts that invite trouble when made too light for their work. The practice in this country until very recently has been to follow so closely the proportion of these parts as used in lighter engines that attention to the present requirements of heavy ones in this direction is a gratifying evidence of an awakening to the needs of the situation. That average American practice in the matter of strength of these details is not equal to that of foreign roads was shown on page 19 of our January issue in the table compiled by Mr. L. R. Pomeroy.

By courtesy of Mr. J. E. Sague, Mechanical Engineer of the Schenectady Locomotive Works, we show in Figure 1 the improved method of fitting driving axles to wheels. This axle has an enlarged wheel fit and a collar $\frac{1}{4}$ inch in length and $\frac{1}{8}$ inch larger in diameter than the wheel fit, the collar having a fillet of $\frac{3}{8}$ inch radius on the wheel fit side. This collar is found advantageous in preventing any tendency of the wheel to move

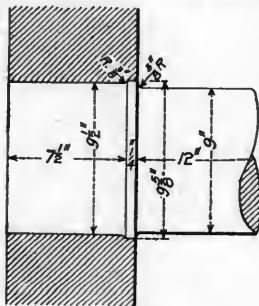


Fig. 1.

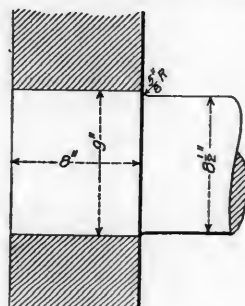


Fig. 2.

Enlarged Wheel Fits for Driving Axles:

on the axle when entering sharp curves, a tendency which is caused on plain axles by the centrifugal force due to high speeds, in spite of the common pressures used in forcing a wheel to place. Figure 2 is another axle having the reinforcement idea well shown. This axle represents the practice on the Chicago & Northwestern Railway. In both of these examples it is seen that the enlarged wheel fit practically eliminates the danger of fracture at the hub, a danger ever present with the reduced wheel fit, and specially aggravated by the removal of stock at the shoulder to form the key seat. The latter trouble has, however, been partially overcome by tapering the key way so as to run easily into the shoulder, which is found to be satisfactory in the case of the shouldered axle, and should be particularly so with those having enlarged ends. The amount of enlargement of the wheel fit is $\frac{1}{2}$ inch, which is considered sufficient in view of the fact that the journals will be kept in service until they are worn down about $\frac{1}{2}$ inch smaller in diameter than they were originally, and therefore the difference in diameter is increased by wear.

BRIEF HISTORY OF THE BALTIMORE & OHIO.

The chronology of the Baltimore & Ohio Railroad is interesting at this time, as it will not be many months before it will cease to be operated under the original charter. The first general meeting of citizens, contemplating the building of a

railroad to the Ohio River, was held in Baltimore on February 12, 1827. The other important events occurred as follows:

Act of incorporation granted by Maryland, February 28, 1827.
Act of incorporation confirmed by Virginia, March 8, 1827.
Requisite amount of stock for organization subscribed by April 1, 1827.

Company organized; directors elected, April 23, 1827.

Preliminary surveys begun, July 2, 1827.

Actual surveys begun, November 20, 1827.

Charter confirmed by the State of Pennsylvania, February 22, 1828.

Maryland became a stockholder, March 6, 1828.

Cornerstone laid, July 4, 1828.

Railroad opened to Ellicott's Mills, 14 miles (horse-power), May 22, 1830.

Trial of the first steam locomotive on the Baltimore & Ohio Railroad, August 25, 1830.

Railroad opened to:

Ellicott's Mills, 14 miles (steam power), August 30, 1830.

Frederick, 61 miles, December 1, 1831.

Point of Rocks, 69 miles, April 1, 1832.

Harper's Ferry, 81 miles, December 1, 1832.

Hancock, 123 miles, June 1, 1842.

Cumberland, 170 miles, November 5, 1842.

Piedmont, 206 miles, July 21, 1851.

Fairmont, 392 miles, June 22, 1852.

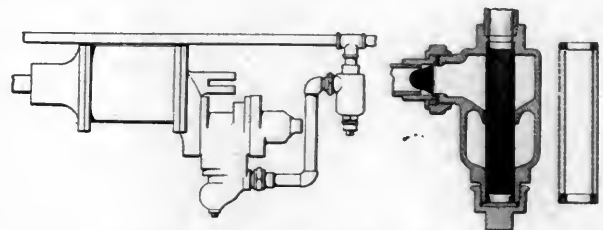
Last spike driven; finished, Baltimore to Wheeling, 379 miles, December 24, 1852.

First train reached Wheeling from Baltimore, January 1, 1853.

Railroad opened, Baltimore to Wheeling, 379 miles, January 10, 1853.

AIR BRAKE DRAIN CUP AND STRAINER.

Our illustration shows a drain cup and strainer gotten up by Mr. Thos. B. Hunt, of Chicago, Ill. The object of this strainer is to do away with the difficulties in cleaning, as en-



Air Brake Drain Cup and Strainer.

countered in some other types, and to provide a simple and durable device that will be reliable at all times. This is accomplished by connecting with the main air brake pipe a drain cup connected to a vertical branch pipe or T-coupling. The cup is provided with a removable screwed cup or plug at its lower end, and the strainer being removably mounted in the drain cup and held in place by the cap, by simply unscrewing the cap, the drain cup itself may be cleaned and the strainer also may be slipped out of the cup, and quickly cleaned and replaced.

CRUSHED STEEL ABRASIVE.

Diamond Steel Emery is an abrasive used in place of emery. The results obtained with it in the Topeka shops of the Atchafalaya road were mentioned on page 13 of our January issue, in which it was stated that this material does not crush or pulverize, and, besides cutting more rapidly than emery, there is less waste. A steam pipe joint is ground very quickly with an amount of this abrasive that may be held on a five-cent piece. We have just received a set of samples of the "steel emery," designated by number, and from its sharpness and uniformity the reason for the rapidity of cutting is clear. Samples may be obtained from the Pittsburgh Crushed Steel Company, Limited, Pittsburgh, Pa.

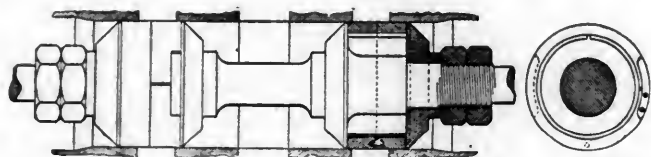
SAFETY DEVICES FOR CAR DOORS.

The facility with which entrance may be effected to the ordinary car loaded with merchandise, leaving the seal intact, without outward evidence of molestation, has led to careful design of safety appliances to cover such cases. Among the best of the most recent efforts to this end are those of the Chicago Grain Door Company, which makes a specialty of the most approved devices for car doors. Their side door bracket, the "Security," is possessed of a vital and interesting feature that is believed will resist the efforts of the most expert crook. The bracket is secured to the sill by a lag screw in addition to the usual bolt through the flange. The lag screw has a total length greater than the width of the bracket from sill to lug, and it can only be introduced by entering the flange diagonally in starting, and this is made possible by coring the hole with a flare on the inner face of the bracket. When the screw is in place, the head is covered by the door, and therefore cannot be reached for removal. This company has also perfected its grain door attachments, and brought them to a simple form. The improvement is in the means of connecting the doors to the vertical rods, and consists of a bracket on the inner face of the door, having an eye-bolt engaging with the rod and free to swivel in the bracket. The advantage of this attachment is in greater freedom from binding when lifting the door—under any reasonable lack of alignment.

A PISTON VALVE USED 65 YEARS.

The accompanying engraving is reproduced from an illustrated description of an interesting old engine by C. E. Wolff, in the "Mechanical Engineer." This engine is used on the Midland Railway, at Swannington, England, for drawing trucks up an incline on a colliery branch.

The engine, which was set to work in 1833, is still used once a week, and is chiefly remarkable for being fitted with a piston valve, of which we give an illustration. As will be seen, the valve is of an ordinary type, each end being fitted with two gun-metal rings, kept up to their work by a steel spring. During the 65 years the valve has been at work it has only twice



An Old and Successful Piston Valve.

been removed for examination. On both occasions it was found to be in perfectly good condition, and was replaced without being touched, and is still working with the original rings.

The shaft consists of a square forging left rough, except for the journals, the fly-wheel being fixed on the square. There is no reversing gear, as the trucks run down the incline by gravity, drawing back the rope. We are not told how often the engine was used during its early life, and we do not know the steam pressure or the amount of work done. The engine is in good condition, and that fact, together with the life of the packing rings, is interesting. The valve is also light in weight and the construction may be suggestive.

The Morgan Engineering Co. of Alliance, Ohio, have found it to be to the advantage of themselves and their customers to sell the product of their works direct, and have terminated the arrangement with the Niles Tool Works Co. Correspondence should be addressed to the home office, Alliance, O., where an able corps of representatives are ready to give immediate attention to all communications.

The tendency to luxury in ornamentation and fittings of sleeping cars has reached a climax in the new cars of the Lehigh Valley in the train service between New York and Chicago. These cars are the latest and finest production of the Pullman shops, and said by that company to be superior to anything yet turned out at those shops. There are several points of

excellence about the cars that will make them specially popular with the traveling public, among which is a very large ladies' room provided with a dresser and toilet conveniences heretofore found only in the best appointed homes. The cars are 78 ft. long over platforms, and of course have all modern accessories, such as wide vestibules, safety steam heat, Pintsch light, etc. The finish inside is of vermillion wood from the East Indies, with handsome inlaid marquetry. The seats are upholstered in Persian design with green border and center pattern in bright colors, which was specially imported for these cars. The head lining ornamentation is the other interior finish, the scheme of which is to give the car an Arabesque effect, and the general air of elegance is heightened by the soft cushion like effect of the heavy rich velvet carpets.

CHANGES ON THE BURLINGTON.

Mr. G. W. Rhodes, for many years Superintendent of Motive Power of the Chicago, Burlington & Quincy, has been appointed Assistant General Superintendent of the Burlington & Missouri River, with headquarters at Omaha. Mr. F. A. Delano, Superintendent of Freight Terminals at Chicago, succeeds Mr. Rhodes as Superintendent of Motive Power. Mr. H. J. Hetzler, Roadmaster at Chicago, succeeds Mr. Delano.

PERSONALS.

Mr. D. C. Courtney has resigned as Master Mechanic of the Middle Division of the Baltimore & Ohio at Cumberland, Md.

Mr. O. O. Winter has been appointed General Manager of the Brainerd & Northern Minnesota, vice Mr. E. H. Hoar.

Mr. Patrick Stack has been appointed Foreman of the Union Pacific shops at Laramie, Wyo.

Mr. E. Pennington, Superintendent of the Minneapolis, St. Paul & Sault Ste. Marie, has been appointed General Manager.

Douglas Stewart has been appointed Master Mechanic of the Rio Grande, Sierra Madre & Pacific, with office at El Paso, Tex., to succeed Mr. H. P. Olcott.

Mr. W. B. Bates has been appointed Master Mechanic of the shops of the St. Louis, Iron Mountain & Southern at Memphis, Tenn.

Mr. S. J. Dillon, heretofore Foreman of the erecting shops of the Pennsylvania at Jersey City, has been appointed General Foreman of passenger car repairs at that point.

Mr. Ethelbert E. Jenks has been appointed Foreman of the Atchison, Topeka & Santa Fe shops at Pueblo, Colo., vice Mr. H. E. Clucas.

Mr. A. F. Seltzer has been appointed Master Mechanic of the Michoacan & Pacific, with headquarters at Zitacuaro, Mex., in place of Mr. E. W. Knapp, resigned.

Mr. G. E. Mulfell has been appointed Master Mechanic of the Grand Trunk at Fort Gratiot, Mich., in place of Mr. R. Patterson, transferred.

Mr. A. E. Bouldridge has been appointed Master Mechanic of the Southern Railway at Louisville, Ky., vice Mr. J. B. Gannon. Mr. Bouldridge was General Foreman at Atlanta.

Mr. W. M. Paul has been appointed Master Mechanic of the Wabash shops at Tilton, Ill., to succeed Mr. G. J. De Vilbiss, transferred to Peru, Ind.

Mr. A. Carroll, of the Canadian Pacific, has been appointed Master Mechanic of the Crow's Nest Pass Line of the above system.

Mr. Benjamin Johnson, for several years in the employ of the Westinghouse Air Brake Company, has been appointed Master Mechanic of the Santa Fe shops at Topeka.

Mr. J. T. Stafford, heretofore General Foreman of locomotive repairs of the St. Louis, Iron Mountain & Southern at Baring Cross, Ark., has been appointed Assistant Master Mechanic of the road, with headquarters at that point.

Mr. P. J. Harrigan, General Foreman of the Baltimore & Ohio shops at Connellsville, Pa., has been appointed Master Mechanic of the Middle Division of that road, with headquarters at Cumberland, Md., vice Mr. D. C. Courtney, resigned.

William T. Moore, formerly for many years Master Mechanic of the Pittsburg Division of the Pennsylvania Railroad, died at his home in Sewickley, Pa., Dec. 1, at the age of 74 years.

Mr. J. R. Groves has been appointed Master Mechanic of the Kansas Midland Division of the Kansas City, Pittsburg & Gulf, with headquarters at Wichita, Kan., vice Mr. C. A. DeHaven, promoted.

Mr. J. E. Mulfeild, Master Mechanic of the Grand Trunk at St. Thomas, Ont., has received the appointment of Master Mechanic of the Western Division, with headquarters at Battle Creek, Mich.

Mr. R. Patterson, Master Mechanic of the Grand Trunk at Fort Gratiot, Mich., has been appointed Master Mechanic of the same road at Stratford, Ont., to succeed Mr. J. D. Barnett, resigned.

Mr. P. J. Milan, Master Mechanic of the Central of Georgia, at Augusta, Ga., has been transferred to Savannah, Ga., as Master Mechanic to succeed Mr. T. B. Irvin. Mr. Irvin goes to Augusta to take Mr. Milan's place.

E. F. Brooks has been appointed General Superintendent of the Philadelphia, Wilmington & Baltimore Railroad, vice Mr. H. F. Kenney, resigned to accept executive duties in connection with lines in this company's system.

Mr. Charles A. Beach, formerly Superintendent of the Buffalo Division of the Lehigh Valley, has been appointed Superintendent of Terminals of the Central of New Jersey at Jersey City, N. J.

Mr. J. H. Goodyear, Chief Clerk to Mr. Tracy Lyon, Master Mechanic of the Chicago Great Western at St. Paul, Minn., has been appointed Assistant General Superintendent of the Buffalo & Susquehanna, to take effect Jan. 7.

Mr. T. H. Yorke, heretofore Foreman of the Chicago Great Western machine shops at South Park, Minn., has been appointed Division Master Mechanic of the Southwest Division of that road, with headquarters at Des Moines, Ia.

Mr. William Fitch, General Manager of the Duluth, South Shore & Atlantic, will succeed Mr. F. D. Underwood, who recently resigned to become General Manager of the Baltimore & Ohio.

Mr. David Van Alstine, Master Mechanic of the Louisville, Henderson & St. Louis, at Cloverport, Ky., has received the appointment of Assistant Master Mechanic of the Chicago Great Western, with headquarters at St. Paul, Minn.

Mr. Charles Treble, Round House Foreman of the "Big Four" at Wabash, Ind., has been appointed Superintendent of the locomotive and car department of the Dayton & Union, at Dayton, O.

Mr. R. R. Hammond, who has been Division Superintendent of the Kansas City, Fort Scott & Memphis, at Springfield, Mo., since July, 1895, has been appointed General Superintendent of that system, including the Kansas City, Memphis & Birmingham, with office at Kansas City, Mo.

Mr. V. A. Riton, at one time Superintendent of the Cascade Division of the Great Northern, and who recently went to the Norfolk & Western, has been appointed Superintendent of the Scioto Valley Division of that road, with headquarters at Kenova, W. Va., succeeding Mr. J. Robinson, resigned.

Mr. W. J. Fransioli has resigned as General Manager of the Manhattan Railway Company of New York, and will become identified with the Auto-Truck Company of New York. Mr. Skitt, who was recently the Manager of the lighterage system of the New York Central, and later elected Second Vice-President of the Manhattan Company, succeeds Mr. Fransioli as Manager.

Mr. J. D. Barnett has resigned as Master Mechanic of the Grand Trunk Railway, in whose service he has been since 1866, his occupancy of the office of Assistant Mechanical Superintendent and Master Mechanic at Stratford, Ont., dating from 1875. Mr. Barnett is one of the oldest members of the Master Mechanics' Association.

Mr. W. M. Greene has resigned as General Manager of the Baltimore & Ohio Southwestern. He will, however, continue as Vice-President and Director of the company, and will represent President Bacon and the interests of the Reorganization Committee and security holders, with headquarters at New York.

Mr. George W. Mudd, Master Mechanic of the Wabash at Springfield, Ill., has been appointed Master Mechanic at Moberly, Mo., in place of Mr. George S. McKee, who is transferred to Fort Wayne, Ind., to succeed Mr. C. H. Doebler, who has been transferred to Springfield. Mr. McKee will also have supervision of the Buffalo Division.

Mr. Mord Roberts, Master Mechanic of the Arkansas Division of the St. Louis, Iron Mountain & Southern at Little Rock, Ark., has had his jurisdiction extended over the Missouri Division, with headquarters at De Soto, Mo., on account of the resignation of Mr. W. H. Harris, heretofore Master Mechanic of the latter division.

Ronald T. McDonald, President of the Fort Wayne Electric Corporation of Fort Wayne, Ind., died of pneumonia in Dallas, Texas, Dec. 24, while on a business trip. Mr. McDonald was the founder of the electric manufacturing industry of Fort Wayne, and by his business ability, sagacity and great energy contributed very largely to the success of the organization of which he was President.

Mr. H. B. Gregg has been appointed Engineer of Tests of the Santa Fe Pacific in the office of Mr. G. W. Smith, Superintendent of Machinery. Mr. Gregg is a graduate in mechanical engineering, University of Wisconsin, and has had a number of years of experience in railroad signaling. He was also connected with the C. & N. W. Ry., and assisted in the Master Mechanics' Association investigation of exhaust pipes and smokestacks. After leaving that road he was engaged at the timber treating plant of the Atchison, at Bellemont, Arizona.

Mr. A. E. Mitchell, Superintendent of Motive Power of the Erie, informs us of the following official changes in his department: Mr. W. Lavery, Assistant Superintendent of Motive Power, is transferred from the Ohio Division at Cleveland to the Erie Division at New York; Mr. George Donohue, Master Mechanic at Meadville, Pa., is appointed Assistant Superintendent of Motive Power, and succeeds Mr. Lavery at Cleveland; Mr. Willard Kells, Master Mechanic at Huntington, is transferred to Meadville, and Mr. John G. McLaren is appointed Master Mechanic at Huntington, the changes taking effect Feb. 1.

Mr. J. S. Turner, Superintendent of Motive Power of the Colorado & Southern Railway, announces the appointments of Mr. J. J. Cavanaugh, Division Master Mechanic at Denver, Mr. D. Leonard at Como and Mr. T. M. Gibbs at Trinidad.

Mr. T. W. Snow, whose long connection with the U. S. Wind Engine & Pump Company has given him a wide acquaintance with the needs of railroad water service, is now also in charge of the Chicago branch of the Otto Gas Engine Company, whose railway interests, and also those of the U. S. Wind Engine & Pump Company, will be jointly taken care of. No better choice could be made for these responsible duties, for the reason that Mr. Snow has devoted as much attention to water service details as any man in this country. His work in the direction of increasing the efficiency of water stations, for the purpose of reducing the time lost at tanks, has left its impress on many of the important lines, and established for him a well-earned reputation.

Mr. Clement F. Street, Member American Society of Mechanical Engineers, has resigned the position of Manager of the Railway and Engineering Review of Chicago to accept that of Manager of the Railway Department of the Dayton Malleable Iron Company at Dayton, O. Mr. Street was formerly chief draughtsman of the Motive Power Department of the Chicago, Milwaukee & St. Paul Railway, and has been connected with the "Railway and Engineering Review" for the past seven years, one year of which he devoted to a trip around the world in the interests of the Field Columbian Museum. Mr. Street has an exceedingly wide acquaintance and is very popular. He is a keen observer, and, being well informed on engineering subjects, he possesses qualifications which promise marked success in his new field.

Mr. Frederick D. Underwood has been called to the management of the Baltimore & Ohio system, with full jurisdiction over the traffic of the road. He was born in Wisconsin in 1849 and his experience has been gained in the West. He has risen through the grades of baggageman, conductor and superintendent on the Chicago, Milwaukee & St. Paul, reaching the position of General Manager of the Minneapolis & Pacific in 1886 and becoming General Manager of the lines forming the "Soo" system in 1888, directing the affairs of the latter road profitably up to the present time. This appointment is the outcome of new blood in the controlling factors of the Baltimore & Ohio property, among which are Mr. James J. Hill, President of the Great Northern, whose gifts as an organizer will assist to place the B. & O. among the prominent paying railroad properties.

W. Dewees Wood, one of the best known steel manufacturers of Pittsburgh, died at his home in that city January 2, at the age of 73 years, after a brief illness. Mr. Wood's family has been closely identified with the iron business of Pittsburgh, and at different times established several important iron manufacturing plants. Mr. Wood's greatest success was in the production of patent planished sheet iron, which now has a reputation for superiority all over the world, and has, in fact, almost entirely driven Russia iron out of the American market. The original works for this product were built in 1851, and have grown rapidly until they constitute one of the largest in their district, the annual capacity being 25,000 tons of planished and other grades of sheet iron per year; the works employ about 1,000 men, and over a million dollars is invested in the plant. The firm of W. Dewees Wood Company was incorporated in 1888, with Mr. Wood as President; Mr. Richard G. Wood, Vice-President and General Manager; Mr. Alan W. Wood, Secretary and Treasurer. During the past few years Mr. Wood has not been actively connected with the concern. This is the only firm of manufacturers of planished sheet iron in this country, and is a splendid memorial of its founder.

EQUIPMENT AND MANUFACTURING NOTES.

The Pintsch light was applied to 1,724 passenger cars during 1898, and the Safety Car Heating & Lighting Company also equipped 902 passenger cars with their steam heating system during the same time.

The J. A. Fay & Egan Company have sold their Chicago branch store to the firm of Manning, Maxwell & Moore of New York City, the sale dating from November 1st, 1898. The latter firm are now exclusive sales agents for Chicago territory for all the wood working machinery of both J. A. Fay & Co. and the Egan Company departments.

The Fox Solid Pressed Steel Company and the Schoen Pressed Steel Company have combined. It is believed that no radical change of manufacture is contemplated, and that the interests of the two concerns is merely consolidated.

The Wagner Company has closed a 25-year contract to operate its parlor and sleeping cars on the Fitchburg Railroad. New equipments will be built for this purpose.

The Union Pacific is remodeling a number of refrigerator cars using the Wickes system of refrigeration and ventilation, as a result of comparative tests extending over a number of years. The Northern Pacific made a similar change some time ago.

The Q & C Company has removed its offices from 100 Broadway, New York, to the corner of Liberty and Church streets, combining offices and salesrooms on the ground floor, where they will carry a stock of machinery and tools of their own manufacture.

Chicago rabbeted grain doors were included in the specifications for 2,000 box cars for the C., C. & St. L. Ry., 1,000 for the Chesapeake & Ohio recently contracted for with the Pullman Company, and for 500 box cars for the Denver & Rio Grande to be built by the Ohio Falls Car Company.

The Q. & C. Company now employs about 200 men in the works near Chicago. The plant is equipped for manufacturing a large variety of specialties, and now includes machines for stamping steel. Power is furnished by two engines, one of 200 and the other 150-horse-power, the boilers being fed by the Q. & C. Scott boiler feeder, illustrated in our issue of February, 1898, page 49.

The Long and Alstatter Company, Hamilton, O., are just completing the largest bloom shear ever constructed in this country. It is for the Loraine Steel Company, and will cut 100 square inches of metal at each stroke. Its total weight is 240,000 lbs., of which over 35,000 lbs. are steel castings, and the main shaft, which is of forged steel, weighs 10,000 lbs. A direct connected engine furnishes the power to drive it.

The Leach Locomotive Sander has made remarkable progress during the year 1898. We have received a statement, showing that it has been applied at the rate of about 182 sets per month, the total being 2,188 sets for the year. The automatic sander is now an absolute necessity, in order to secure the necessary adhesion of locomotives, with the tendency to increase cylinder power.

Passed Assistant Engineer Walter M. McFarland, who has been attached to the Bureau of Steam Engineering as assistant to the Engineer-in-Chief, leaves the naval service to enter that of the Westinghouse Electric and Manufacturing Company as Assistant General Manager. This is in line with the policy of the Westinghouse interests, to take the best engineering talent to be found.

The Westinghouse Electric and Manufacturing Company has the contract for changing the motive power of the Third Avenue Railway Company to electricity. From five to six million dollars are involved in this contract, which contemplates a power plant at 216th street, with a capacity of 64,000 horse-power, which will be in excess of anything thus far built.

The Chicago Grain Door Co. have just received the order for rabbeted grain doors for 700 Chicago Great Western box cars recently let to the Michigan Peninsular Car Co.

Mr. C. F. Quincy, President of the Q and C Company, has won a handsome cup bearing a striking likeness of himself, probably from a photograph, taken while playing golf. We do not mean that he won the cup by playing golf. He may be able to do so, but this cup is a token of esteem presented by his business associates and the local agents of the concern. It is a beautiful testimonial of the high regard in which he is held.

The lease of the Cambria Iron Company's works by the Cambria Steel Company has brought about the consolidation of the New York offices, formerly at 100 Broadway and 33 Wall street, at the new Empire Building, No. 71 Broadway, in rooms 1705 and 1706. Mr. H. L. Waterman is general sales agent for New York City and vicinity, and will give special attention to the sale of structural steel, steel blooms, billets and slabs. Mr. W. A. Washburne will handle negotiations for steel rails and railway track fastenings, and Mr. L. R. Pomeroy still gives attention to steel axles and other forging specialties.

Mr. H. J. Martinez, Member American Society of Mechanical Engineers, has been appointed Resident Agent at Havana, Cuba, for the Aultman & Taylor Machinery Co. of Mansfield, Ohio, manufacturers of the "Cahall" vertical and the "Cahall" horizontal water tube boilers. The business will be conducted under the name of Mr. H. J. Martinez, Consulting and Contracting Engineer. He will be prepared to submit estimates on the products of this company, the vertical type of boiler being claimed by them to be especially well adapted to the conditions and requirements of the sugar industry in Cuba and Porto Rico.

The passenger department of the Southern Pacific is taking the proper course to let the public know about their new fourteen-hour train between San Francisco and Los Angeles. This train, known as the "Owl," comprises, at this time, the regular equipment of the road, made up of a day coach, composite car, two high-class wide-vestibule Pullman drawing room sleeping cars, and a dining car. Travel between these two cities having lost its intermittent character, this train has been put on to meet the demands of rapid growth. New equipment is now being constructed for the "Owl," which will be a solid, wide-vestibuled train from end to end, with every modern elegance and convenience.

The Babcock & Wilcox Company have taken from Westinghouse, Church, Kerr & Company the largest stationary boiler order that has ever been placed. The boilers are for the power plant which the Westinghouse Electric Company have contracted to build for the Third Avenue Railroad Company at 218th street and Harlem River, New York, and which is to be constructed by Westinghouse, Church, Kerr & Company. The order covers sixty Babcock & Wilcox forged steel boilers of 520 horse-power each, or an aggregate of 31,200 horse-power. The boilers are to be capable of carrying 200 lbs. steam pressure. They will supply steam for compound condensing engines of 64,000 nominal horse-power in the aggregate. Added to large steaming capacity the Babcock & Wilcox boilers have a record for extremely low cost of maintenance.

The Duff Manufacturing Company of Allegheny, Pa., have issued a pamphlet in which the Barrett patent compound lever jack is described as combining all the qualities recommended by the Committee on Track Jacks, appointed by the Roadmasters' Association in convention in Indianapolis. Twenty different styles of jacks are shown in the pamphlet, for every conceivable requirement. The Barrett jacks are guaranteed to be positive and quick in action, and they are simple and easy in movement. The materials used in construction are of the strongest and best. In a list of railroads using these jacks we count 134 of the best, most important and most successful roads in the United States.

The Long Island Railroad is rapidly transforming its locomotives into anthracite burners, in compliance with the demands of the New York Board of Health for elimination of the smoke nuisance. Nine new anthracite burners have been ordered, 19 engines are undergoing the necessary alterations to burn the smokeless fuel, and 16 engines are already using anthracite coal.

The New York Central is to erect a new building for the Young Men's Christian Association, at a cost of about \$20,000. It will be 40 by 99 feet, and located at Seventy-second street freight yards, New York City, to take the place of the quarters which they have outgrown.

The McCord journal box and lid is being applied to 50 cars for the Brainard & Northern Minnesota, 500 flat cars for the Northern Pacific at the Barney & Smith Car Co., 1,450 cars for the Delaware & Hudson, 700 box cars for the Chicago Great Western at the Michigan Peninsular, and 200 cars for the Chicago & West Michigan.

The Bangor and Aroostook has ordered three locomotives from the Manchester Locomotive Works.

The Fitchburg Railroad is having ten locomotives built, two by the Manchester Locomotive Works and eight by the Schenectady Locomotive Works.

In the year just passed the Baldwin Locomotive Works completed 760 locomotives, representing every service in which a locomotive is used. Much of the output was shipped to foreign countries, the larger part going to Japan and Russia. This record does not, however, reach that of 1891, when 946 engines were built, which very nearly reached the estimated capacity of the works. The present year opened with orders for 200 engines, and they are still coming in. These orders are mostly for rapid delivery, and the works are running day and night in consequence.

The Chicago Great Western has ordered ten 10-wheel engines from the Baldwin Locomotive Works. The order is for March delivery, and is equally divided between simple and compounds, the former to be 20 by 28 inches and the latter of the Vauclain type, 16 by 26 by 28 inches stroke. The driving wheels are 63 inches diameter and will have an adhesive weight of 123,000 pounds, and the weight of the engine in working order is to be 163,000 pounds. The fireboxes will be above the frames, with a width of 42 inches and length of 112 inches. The tenders are large capacity, holding 6,000 gallons of water and 10 tons of coal.

The Rogers Locomotive Works have a contract with the Great Northern for 35 engines, 25 of which will be 12-wheel, for freight, and ten 10-wheel for passenger service. The latter engines will have cylinders 18 by 26 inches, cast steel driving wheels 73 inches diameter, with 97,000 pounds adhesive weight, and a total weight of 197,000 pounds. The boilers are to be of the Belpaire type, designed for a pressure of 210 pounds. Capacity of tender for water, 4,500 gallons. The freight engines are to be 19 by 32, with 55-inch drivers of cast steel. The adhesive and total weights of these freight engines will be 152,000 and 182,000 pounds respectively. The boilers will be Belpaire, with extended wagon tops, and also designed for 210 pounds pressure. Capacity of tender for water, 5,000 gallons.

The Erie has ordered four compound engines of the Atlantic type from the Baldwin Locomotive Works. The chief characteristics are as follows: Weight on drivers, 82,000 pounds; total weight, 142,000 pounds; cylinders, 13 and 22 by 26 inches; drivers, 76 inches diameter; Wootton boilers designed for 200 pounds pressure; fire boxes, 96 by 96 inches; tender, 6,000 gallons of water and 20,000 pounds coal. Orders have also been given for twenty simple 10-wheelers, fifteen of which will be built at the Richmond Locomotive Works and five at the Rogers Locomotive Works. Weight, 144,000 pounds, with 105 pounds on drivers; cylinders, 20 by 26 inches; drivers, 63 inches diameter, and boiler pressure 180 pounds; fire box, 40½ inches wide and 107½ inches long. Water capacity of tender, 6,000 gallons; coal capacity, 20,000 pounds.

Since the publication of our article on short smoke boxes for locomotives, on page 391 of our December issue, 1898, we have received several communications on the subject, among which is one stating that the Brooks Locomotive Works are putting on Mr. J. Snowden Bell's arrangement whenever they can do so, and that they consider it the best form to use. It is being applied to three consolidation engines with wide fire-boxes, 72-inch boilers and 21 by 26 inch cylinders for the Long Island Railroad and on large 10-wheel passenger engines for the Buffalo, Rochester & Pittsburg and others. These fronts have been applied to more than 100 heavy locomotives built at these works, which is a good indication of progress in front end reform.

In accordance with the plans formulated two years ago by the receivers to place the Baltimore & Ohio Railroad in first-class physical condition, considerable work is being done on the Trans-Ohio divisions. The improvements are being made with a view to using 70-ton locomotives on all portions of the line, and since July 9, 290 tons of 75-pound and 12,943 tons of 85-pound steel rails have been laid on the Central Ohio, Lake Erie and Chicago divisions. About 17 miles of new side tracks have been constructed, five telegraph towers erected, a new freight depot built at Mansfield, Ohio, an interlocking plant installed at Plymouth, Ohio, and five water stations, to expedite freight traffic, constructed. Further improvements of a more extensive character are being planned, in order to materially increase the train haul.

The Pennsylvania Car Wheel Company, of Pittsburgh, young as it is, has made such strides forward that it has found it necessary to add a new area of 10,000 square feet to its shops. This company has just passed its first year of organization, having been incorporated Jan. 4, 1898, and in April next it will have passed its first year of production. Though new as the Pennsylvania Car Wheel Company, the members of the corporation are by no means new in the business, Mr. C. V. Slocum, secretary and treasurer, having been identified for years with the New York Car Wheel Company, at Buffalo. The company points with proper satisfaction to the fact that its wheels have passed the exacting P. R. R. tests, made before the representatives of Mr. F. D. Casanave, Superintendent of Motive Power at Altoona, as well as those of the Schoen Pressed Steel Company, both of which are users of the Pennsylvania wheels.

Six new sleeping cars are being built at the Wagner Palace Car Company's shops at East Buffalo for use in Wagner service. The remarkable feature of these new cars consists of a greater length than heretofore used in sleeping cars, the bodies to be 74 feet in length, as against 70 feet for the longest of these cars they have built. There are some private cars that may exceed these in length, but they will be longest sleepers ever built. One advantage in the increased length of these cars will be a greater length of berth than can be had in the ordinary sleeper, and the improvement will be one giving a passenger a greater sense of freedom than is now enjoyed in the smaller ones.

The capacity of the plant of the Westinghouse Electric and Manufacturing Company at East Pittsburgh is to be doubled, the contracts for the extensions having recently been closed, which will make these works the largest in this country, if not in the world. The new buildings will add about four acres to the floor space. The machine shop as it stands is 750 feet long; this will be increased to 1,000 feet. A building six stories high will be devoted to the uses of the officers, engineers, draftsmen and clerks. The extension to the machine shop of the Westinghouse Machine Company will be architecturally the same as the old shop which it is to join, with walls of brick and frame of steel. The largest contract ever received by this concern closed a few weeks since, and said to be the largest ever awarded to any firm of engine builders, was that from the Brooklyn Light and Power Company, for an installation in its power house now in course of construction, of 18 engines, with units of 5,000 horse power. The engines for the Metropolitan Construction Company of London are now completed at these works.

The business of the Chicago Pneumatic Tool Company for the year just closed may be inferred to be good when it is understood that the rate of increase was so rapid that the volume of trade for the last month of 1898 was four times that of the same month of the preceding year. The causes for this flattering business situation are to be found not so much in the new openings for compressed air as in extension of the use of the ingenious pneumatic tools built by this company. The United States Government has recently shown its appreciation of their labor-saving devices by awarding contracts for the equipment of the navy yards with them. The foreign trade is reported to be keeping pace with the growing demand for their specialties in this country, the tools having been adopted by prominent shipbuilders on the Clyde and in important manufacturing establishments in England and on the Continent. The increased use of these pneumatic tools is explained by the wide range of work they are designed to cover, embracing, as they do, almost everything in the manufacturing line from railroad shops to navy yards.

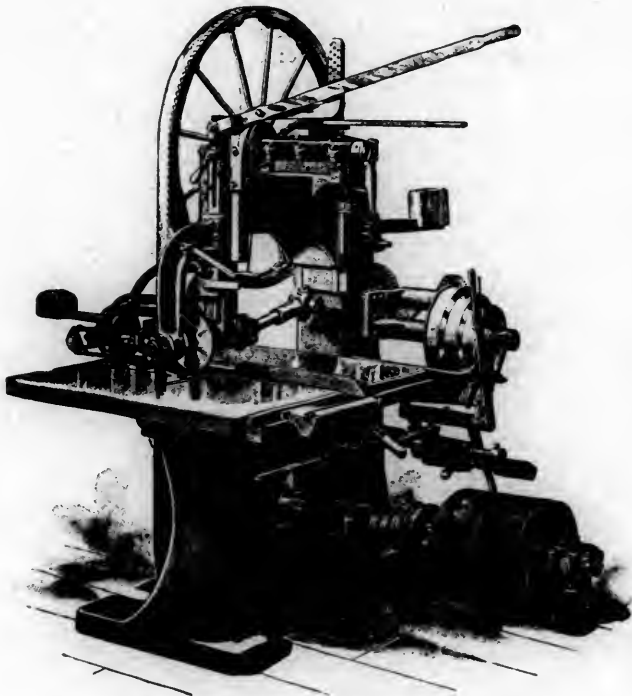
Gas engines having come very much into vogue as the best driver for pumping stations for railroads, the F. M. Watkins Company of Cincinnati are urging their "Sumner" engines as particularly well adapted for such use. The "Sumner" engine is said to be the outgrowth of fifteen years' experience, and many installations are to be seen where the requirements are the same as in railroad pumping station work. The great advantages of gas engines for pumping station work are obvious. The expense of keeping up steam continuously, whether power is needed or not, is wholly eliminated, as well as the cost and annoyance of handling coal and ashes. Then, too, no engineer is required to operate a gas engine, little instruction being needed to make any one competent to operate one. The gas engine furnishes a motive power ever at command, easy to start or instantly stop, safer from danger of fire than steam, and very much more economical. Moreover, there is no expense while the power is not being used. The Watkins Company ask a hearing with parties interested, and the class of present customers named by them is an indorsement of their claims.

It was reported that Pintsch gas exploded and caused a fire that destroyed four cars of a wreck of an Atchison limited train near Trinidad, Col., December 28, but after thorough investigation the officers of the road say that the gas-lighting equipment had nothing whatever to do with the fire. Such accusations have been made before, and, as far as we know, with the same result. Wide experience with this apparatus shows that it does not explode, even when the cars are destroyed by fire. The gas tanks may become heated, but before a dangerous pressure can be produced the rubber gaskets or the soldered joints will give way and provide escape for the gas; and, we are told, it burns quietly. A mixture of air and gas with a large proportion of air is necessary to produce an explosion, and it is difficult to comprehend how such a condition can occur. The smell of gas is noticeable when only a fraction of 1 per cent. is present in the air, and that this is sufficient to scare people at a wreck who are already excited, and lead them to believe themselves to be on the verge of a horrible explosion is the only explanation we can think of to account for the tendency to charge fires against Pintsch gas. There are 85,000 cars using this system of lighting, and we believe the record for safety to be perfect.

A NEW AUTOMATIC BAND RIP SAW.

Our illustration of the automatic band rip saw shows one of the latest productions of The Egan Company, of Cincinnati, O. The machine takes in 24 inches between the saw and the adjustable fence, and 10 inches under the guide. It has three feed speeds, in and out feeding rolls, and an improved straining device which controls the upper wheel and the path of the saw blade on the face of the wheels. This device has an adjustment in every direction in a horizontal plane, and is of the most sensitive character, taking up the slack in the blade in-

stantly under all service conditions. The wheels carrying the saw blade are 42 inches in diameter, of iron and steel, the upper one having spokes, and the lower one a solid web, the object of which is to prevent the stirring up and circulation of dust at the floor. There are powerful feeds of 60, 90 and 130 feet per



A New Automatic Band Rip Saw.

minute, but faster feeds are furnished when desired. The advantage of the in-and-out feeding rolls lies in the fact that very short stock may be worked up with facility; these rolls are capable of instant adjustment, up or down. The machine is furnished with a blade of $2\frac{1}{2}$ inches by 20 feet, although blades up to 3 inches wide may be used. This machine is the latest result of expert effort in tool improvement by the Egan Company.

BOOKS AND PAMPHLETS.

Proceedings of the Sixth Annual Convention of the Traveling Engineers Association, held at Buffalo, N. Y., September, 1898. Edited by W. O. Thompson, Secretary, Elkhart, Indiana, 1898. 217 pages (standard size, 6 by 9 inches).

This pamphlet contains a complete report of the 1898 convention, the committee reports and discussions, a list of members and the constitution and by-laws. The object of the association, as stated in the constitution, is to "improve the locomotive engine service of American railroads." This is admirably supported in the present volume, which is full of practical thoughts concerning methods of improving the handling of locomotives with economy and efficiency. It is a volume that may be read with profit by the higher mechanical officers. The report is well edited, and it shows the careful work of the secretary, which is particularly apparent in the index. The attention given the index is well worth while, and it will be appreciated by those who have occasion to refer to the opinions expressed in the reports.

Cuba: Its Resources and Opportunities. By Pulaski F. Hyatt, United States Consul, Santiago, Cuba, and John T. Hyatt, United States Vice-Consul, Santiago; 211 pages; illustrated. New York, 1898, J. S. Ogilvie Publishing Co., 57 Rose street. Price, \$1.50.

The authors of this book, having spent nearly six years in Cuba in the United States Consular Service, enjoyed exceptional opportunities for observation concerning the natural resources of the island, and they were naturally called upon to give information to many who desired to learn about business opportunities there. The demand for information became so great as to necessitate putting their knowledge and experience into

the form of a book. A large portion of the space is devoted to the natural resources of the island, and important suggestions are made as to methods of utilizing the present facilities for transportation. The political and geographical conditions and the character of the people, the labor, commercial and climatic conditions are also treated. Not the least valuable chapter is one giving a business directory of the island, with the names and addresses of tradesmen located in each of the provinces. The book will be valuable to those who are seeking to form trade relations with Cuba.

The Story of the Railroad. By Cy Warman. Published by D. Appleton & Company, New York. Illustrated by B. West Clinedinst. 1898. Price \$1.50.

This is an intensely interesting account of the inception and early history of the railroads crossing the Western plains and mountains to the Pacific coast. It presents not only the story of the Western railroad, but tells us the character of those most courageous and devoted men, the locating engineers, who suffered and sacrificed more than any writer can tell. The story exhibits the life that grew out of the peculiar roughness of the new country, and the constant danger to person and property. It is full of anecdote and accounts of times that were stirring, when it was necessary to "flag with firearms" and when every new city began with a graveyard. The discouragements of the promoters, the hardships, privation and often death of the "pathfinders," the difficulties of construction and the early problems in operation are all told in an interesting, entertaining way. The book gives such a broad and correct view of the development of the Western country, and the influence of the railroad upon it, that everyone should read it for the sake of knowing how all this was done. We find great satisfaction in Mr. Warman's memorial to the locating engineer. All the way from the Atlantic to the Pacific he has been forced to fight, leaving along his new-made trail heaps of bleaching bones that tell of his trials, and marvellous feats of engineering that speak of his skill. Mr. Warman has written an interesting and inspiring book, that is not disappointing in any way.

Fowler's Mechanical Engineer Pocket Book. By Wm. H. Fowler, editor of "The Mechanical Engineer"; 324 $3\frac{3}{4}$ x 6-inch pages, with 22 illustrations. The Scientific Publishing Company, Manchester, England. Price one shilling sixpence.

To properly review a pocket book for engineers it is necessary to use it, but we can say that this volume is a surprise in the amount of matter put into such a small volume. It costs only about 35 cents in our money, and this is accounted for by a large number of advertisements which it includes. The book is divided into sections, and each of these was intrusted to an engineer who had made specialties of its subjects. Steam boilers, transmission of power, general notes, tables and arrangement are by the editor, who is an authority on boiler work. Other subjects are treated by men as well qualified to handle them. We note one on locomotives by C. E. Wolf, of the staff of the Midland Ry. The book is not a treatise on any subject, and the formulas are not worked out, it being taken for granted that they are correct. A large amount of information is presented. It appears to be well planned, well considered, well edited and it has a good index.

A graduates' magazine—"The Technology Review"—has just been issued by the recently organized Association of Class Secretaries of the Massachusetts Institute of Technology. It is an octavo volume of 140 pages, attractive in appearance and of the best workmanship. The cover, designed by Hapgood and printed on Army brown paper, is very handsome. The first number contains the announcement; a photograph, with biographical sketch, of President Crafts; articles on "The Function of the Laboratory," by Professor Silas W. Holman, and on the "Pierce Building," by Professor Eleazer B. Homer, the architect; also reprints, in fac-simile, of early institute documents and letters. The latter half, seventy pages, is given to news of the Institute of the undergraduate and graduate classes. Plans are shown of the several floors of the new Pierce Building, of the first floor of the Rogers Building, as now altered, and of the dynamo house. There are two half-tone inserts and two line-drawings, one by Gelett Burgess. An excellent review of Professor Holman's recent book on "Matter, Energy, Force and Work," is given by Dr. Goodwin. This is one of the most interesting of the "Tech." periodicals we have seen, and is creditable from every point of view.

Repairs of Railway Car Equipment, with Prices of Labor and Material. A Reference Book for Railway Officials, with Average Shop Cost of Repairs to Passenger and Freight Cars. By H. M. Perry, 172 pages, cloth. Published by the Railway Age, Chicago, 1899. Price, \$2.00.

Mr. Perry has had 30 years' experience in railroad car work, and presents the information in regard to cost of car building and repairs that he has found desirable to have in connection with his work. The book contains detail bills of materials for cars, trucks, platforms, roofs, doors, etc., and tables of the weights of iron and other material, also tables of board measure and weights, and sizes of bolts, nuts, washers and other minor details. The prices for both labor and material for freight cars are based, as far as possible, on the prices in the code of rules of the Master Car Builders' Association, governing the repairs to cars and from these damaged car reports will be correct, under the present rules, for all sections of the country. It is apparent that if the rules change, the plan is somewhat upset, but this may be provided for in future editions of the work. The compilation of this information required a large amount of work, and the minuteness of details is its greatest recommendation. The tables are divided into small units, and the prices and weights of parts are grouped for convenience in taking off the costs of the units as well as the totals, and in general the book is admirably arranged. The costs of special equipment, such as vestibules, couplers, air brake and Pintsch light, are given in groups and in detail, and the criticism applied to these is equally applicable to all the prices, namely, they are subject to change, and it would be well, unless a new edition appears every year to provide blank columns for changes in the prices. The tables of useful information in the closing pages include a great deal of matter that has appeared in other publications, but it will be found convenient to be able to turn to it in connection with the items concerning cars. We believe that every officer having to do with cars, and especially those who handle bills for repairs, will need and will appreciate the book. It has great value aside from the prices. We do not know where else to find so much information on the subject of weights of parts. The book is well printed and bound, and is a credit to the publishers.

Railway Economics. By H. T. Newcomb, LL.M., Chief of the Section of Freight Rates in the Division of the Statistics of the United States Department of Agriculture, and Instructor in Statistics and Transportation in Columbian University. Philadelphia: Railway Publishing Company, 1898.

This has appeared in serial form in the "Railway World," and at the request of the railway officials it was compiled in book form. The subjects include transportation, capitalization, income and expenditure, the decline of charges, rates and prices, causes of the decline of charges, competition, the law of increasing returns, unjust discrimination, long and short haul charges, pooling associations, taxation and construction. Many statistics are presented, and the position and experience of the author is a guarantee that they are correct. The chief object of the book is to show the position of the railroad in the present organization of industry in the United States. It is a concise statement of the author's ideas of the necessities of the present situation.

Indicator Diagrams and Engine and Boiler Testing. By Charles Day, M. I. M. E. Second edition, 212 pages. Illustrated. The Technical Publishing Company, Ltd., 31 Whitworth Street, Manchester, England. D. Van Nostrand Company, 23 Murray Street, New York. Price four shillings sixpence.

This book has two prime objects. First, to explain the construction and use of the indicator; and, second, to discuss the testing of engines and boilers. The part devoted to the indicator gives a great deal of attention to defective indicator diagrams, and uses them as instances of the modes of reasoning applicable to indicator diagrams generally. These diagrams are instructive and interesting, also as a study of valve action. The part devoted to boiler testing includes a very complete table of piston constants, compiled by Mr. W. H. Fowler. It also includes discussion of coal and gas analysis. The fact that the book has run through its first edition so soon is evidence of its popularity.

Commercial Relations of the United States, 1896 and 1897. Vol. II., Europe. Department of State, Washington, D.C., 1898.

This is the companion volume to that noticed in these columns in our December, 1898, issue. It is issued by the Bureau of

Foreign Commerce of the State Department, and contains statements with regard to the commerce of the United States with all of the European countries.

The Customs Tariff of Japan. In effect Jan. 1, 1899. Published by the Japan-American Commercial and Industrial Association, Times Building, New York. Paper, 44 pages.

This pamphlet contains the tariff laws of Japan and tables of the specific and ad valorem duties on articles imported into the country, also the conventional tariff between Japan and Great Britain and the principal European countries. It is a valuable publication for those who are engaged in trade with Japan. Copies may be had from the association at the address given above.

Proceedings of the Twenty-ninth Annual Convention of the Master Car and Locomotive Painters' Association of the United States and Canada, held at St. Paul, Minn., September, 1898. Published for the association by the Railroad Car Journal, New York. Standard size, 117 pages, illustrated.

This volume contains the name and addresses of the members of the association, the constitution and by-laws and the proceedings of the 1898 convention, including the reports and the discussions. This is a record of the progress of car and locomotive painting, and that of the opinions of the men who are best informed.

The Railroad Officials' Diary, published by the Railroad Car Journal, 132 Nassau street, New York. Price, \$1.00.

This book is standard size, 6 by 9 inches, and has a blank page of good quality of white paper for every day in the year. It is bound handsomely in flexible leather, and is very convenient for records or appointments. It contains a list of the railroad technical organizations, their officers and dates of meetings, and also railroad statistics from the report of the Interstate Commerce Commission, arranged in convenient form, and a list of leased railroads.

The Lehigh University, Origins and Destiny. An address delivered on Founders' Day, Oct. 13, 1898, by Langdon C. Stewardson, Chaplain of the University. Paper, 26 pages. Published by the University, South Bethlehem, Pa., 1898.

Bulletins of the United States Geological Survey, Nos. 151 to 156 inclusive. Department of the Interior, Government Printing Office, Washington, 1898.

Transactions of the American Society of Mechanical Engineers, Vol. XIX., 1898. Published by the society, New York, 1898.

This volume contains the usual list of officers, the rules of the society, the papers and discussions of the 36th and 37th meetings. It is printed in the usual satisfactory style, and is accompanied by an excellent index.

Cassier's Magazine for January contains an admirable article on the arrangement of railroad shops by Mr. William Forsyth, Superintendent of Motive Power of the Northern Pacific Railway. The author presents plans of 13 representative shop plants and discusses the principles involved in the ideas of the designers. It is the best general article on the subject that we have seen.

Valentine & Company, the well known varnish manufacturers, have issued a very attractive pamphlet of their numerous awards at the expositions where their goods have been displayed. The reproductions of the engrossed work are in the form of beautiful half-tones, and the medals are reproduced in bronze, which gives a very clear idea of the originals. The catalogue is a work of art and worthy of preservation even by those who are not interested in a commercial way in the industry that is able to present such interesting evidences of appreciated merit.

LICENSES

To be sold in each district for Patent Safety Apparatus for Gauge Glasses adaptable for any kind of steam boiler. United States Patent No. 409,280. Greatest success in Europe under Government control and legalized introduction. First-class technical firms only are invited to correspond with HERREN LEYMANNS & KRIM, Aix La Chapelle, Germany.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

MARCH, 1899.

Table of Contents will be found on page 86.

LOCOMOTIVE DESIGN.—THE WORKING STRENGTH OF MATERIALS.

By F. J. Cole, Mechanical Engineer, Rogers Locomotive Works.

Main or Connecting Rods.

The force which the main connecting rod transmits to the driving wheels is the piston effort, that is, its area multiplied by the initial steam pressure. This, with but a very slight reduction for friction in the cylinder and in the rod stuffing box, is borne by the main rod, either as a tensile stress as the piston is pulled into the cylinder, or as a compressive stress tending to bend it in the direction of its least width as the piston is thrust out. The centrifugal force caused by the back end whirling around the crank and being thrown upward and downward causes transverse stresses, reaching a maximum in the outer fibres, alternating from tension to compression and vice versa for each revolution.

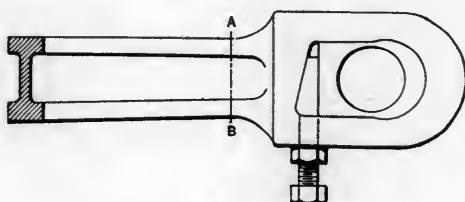


Fig. 1.

The sectional area required to resist the pull of the piston is a simple matter of dividing the total piston effort by some predetermined and allowable stress per square inch. The weakest part of a main rod is usually the front end, either the strap or the bolts, and where the rod is made of I section it is the grooved part immediately back of the stub or solid end. Often the front and back ends are made in proportion to the diameter or size of the crank and wrist pins to which they are connected—made to "look right," irrespective of the force which has to be transmitted—and as a consequence the crosshead wrist pin being comparatively small, the front end connections are made to harmonize. Leaving out for the present all questions relating to the strength of the rod to resist bending or buckling when considered as a column or its stiffness as a beam to resist the stress due to the centrifugal force caused by the vertical motion of the rod, as it vibrates up and down, following the motion of the crank pin; the fibre stress per square inch of section should not exceed 8,000 pounds, that is for every 8,000 pounds of piston effort there should be allowed one square inch of metal. This refers particularly to the front end of I section rods, the part just back of the stub where the channelling commences shown at A-B, Fig. 1. In rectangular sections there is usually an excess of metal at this point, so that little attention need be paid to the area, the weak places being in the straps or in the solid ends. In I section rods with strap ends, when the metal is milled out for the sake of lightness, as in Fig. 2, it is desirable to leave the area at C-D slightly in excess of that of the body just back of the strap. This is based on the experience gained from a number of broken rods made of a good quality of steel of 70,000 to 80,000 pounds tensile strength. The reason is doubtless due to the fact that the rod at this point is reinforced by the strap and rigidly confined, concentrating the vibrations and minute bendings at the bolt hole, the support outside the hole not being sufficient to compensate for the reduction in strength due to the hole.

The straps or solid front ends should be designed so that the stress at the weakest part, usually at the key or bolt holes, should be less than 8,000 pounds per square inch, the working stress could then be taken as ranging from 6,000 to 8,000 pounds. If one side only is reduced by reason of a hole or keyway, the area for both sides should be taken as twice the weakest side and not the actual net area.

Unlike the parallel rods, the normal force transmitted through the main rod is not increased to any material extent by unequal adhesion, improper quartering, etc., therefore the fiber stress may be taken at a much higher figure.

Viewing the rod as a column with flat ends its resistance to bending or buckling may be found by means of Johnson's parabolic formulae described in detail in the preceding paper on parallel rods. For convenience they are again given briefly as follows:

Ultimate strength in pounds per square inch, wrought iron columns, flat ends, ratio less than 210

$$P = 34,000 - .43 \left(\frac{1}{r} \right)^2$$

Mild steel columns, flat ends, ratio less than 190

$$P = 42,000 - .62 \left(\frac{1}{r} \right)^2$$

Table 1 is calculated from these formulae. It will be found convenient for rapidly determining the correct form of section and the required area of the rod, forming a useful adjunct to

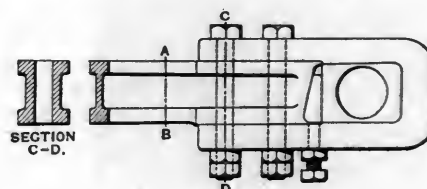


Fig. 2.

diagram No. 6, given in the preceding article. (Page 55, February issue.)

Table 1.

$\left(\frac{1}{r} \right)$	Ultimate Strength Per Square Inch.		Ultimate Strength Per Square Inch.	
	Wrought Iron.	Medium Steel.	Wrought Iron.	Medium Steel.
50	32925	40450	130	26723
55	32699	40125	135	26163
60	32450	39768	140	25572
65	32183	39380	145	24959
70	31893	38962	150	24325
75	31581	38512	155	23669
80	31248	38032	160	22992
85	30893	37520	165	22293
90	30517	36978	170	21573
95	30119	36404	175	20831
100	29700	35800	180	20068
105	29259	35164	185	19283
110	28797	34498	190	18477
115	28413	33800	195	17649
120	27808	33072	200	16800
125	27281	32312		17200

It is evident that the rod offers the least resistance to bending in a horizontal plane, therefore the width and not the height largely determines its ultimate strength to resist the push of the piston, the greater depth being required to resist the centrifugal force caused by the back end following the path of the crank pin. A factor of safety of from 2.5 to 3 should be allowed, based on the ultimate resistance to bending horizontally in the direction of its least width. As the factor is taken at the elastic limit of the material, it will be found to give an ample margin of strength. A number of rods having a factor of 2.4 have been in service for several years without any known breakages. This applies particularly to rods of I section. Those of plain rectangular section usually have a greater cross sectional area to resist the direct push and pull of the piston, but they have an increased weight without a greater resisting power to withstand the increased centrifugal force.

To design a main rod it is necessary to know in advance the diameter of the cylinder, the boiler pressure, its length from center to center, the piston stroke and the strength of the

material. The maximum piston force which the rod has to transmit is the area of the cylinder multiplied by the boiler pressure. This divided by 8,000 for steel and 7,000 for hammered iron will give the number of square inches required in the smallest part. As most main rods for large engines are lightened by grooving or channeling, a suitable I section having the required sectional area should be selected; from this an approximation to the depth of the section at the center of the rod may be assumed. Find its area in square inches and its least radius of gyration; also the ratio of the length divided by the least radius of gyration. Then from the table take its ultimate strength per square inch. This, multiplied by its sectional area, will be the ultimate bending strength of the rod. The product divided by the piston force will give the factor of safety.

To investigate the action of centrifugal force upon the main rod and to determine the maximum bending moment caused by this force, the weight of the rod, the velocity in feet per second and the radius of the path of the moving body must be first ascertained. Inasmuch as the rod is moving in a straight line at one end, while the other is revolving around the crank pin, it is evident that the centrifugal force is at its maximum at the crank end, gradually decreasing until it becomes zero at the front or crosshead end. In Fig. 3 the elliptic path of a fixed point in the middle of the rod is shown. As the maximum force to produce transverse bending is exerted when the crank is at its highest or lowest position, the velocity between the points A, B and C will be the same as the crank circle, but the radius of the curved path will be much greater. Therefore, as $F = \frac{w v^2}{r g}$ (see page 22, January issue),

the force will be less. The simplest way to calculate the bending moment is to make a diagram like Fig. 3, in which:

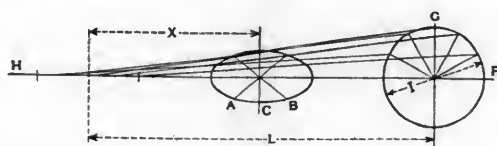


Fig. 3.

L = the length of the rod between centers.

I = the radius of the crank.

The ellipse in the center, of which A, B and C are a part, is the path of the center of the rod. Then the radius of the curve passing through the points A B C can be obtained. Assuming the velocity between the points A and B to equal that of the crank circle, the centrifugal force can easily be calculated by substituting the radius thus found for the radius of the crank. The centrifugal force for any portion of the rod can be found, approximately, by the following formula:

Let F = centrifugal force at crank circle.

X = distance from center of front end to point where the stress is calculated.

Y = centrifugal force at point.

L = length of rod between centers.

$$\text{Then } Y = \frac{F \times X}{L}$$

As the transverse bending in the center of the rod due to the centrifugal force will be only equal to half that due to the velocity and radius of the crank pin, it will generally be found that the modulus of section, taken at the center, for the usual forms of rods, will be sufficiently large, either of the rectangular or I sections, to provide an ample factor of safety. The force expended in acceleration and the inertia of the reciprocating parts reduces the maximum amount transmitted to the crank pin through the main rod. The minimum effect of these modifying forces is at starting and slow speeds, increasing as the square of the velocity.

The following example is a main rod of a 20x24-inch consoli-

dation locomotive with steam pressure 180 lbs. per square inch and section in center, as in Fig. 4:

Moment of inertia = 3.417, axis perpendicular.

Area of section = 7.78.

Least radius of gyration = .662.

Length of rod between centers = 131½ inches.

Thrust of piston, $20^2 \times .7854 \times 180 = 56,520$ lbs.

Material—Steel of 70,000 to 80,000 lbs. tensile strength.

Ultimate strength to resist buckling or bending sideways, axis perpendicular:

$$42,000 - .62 \left(\frac{1}{r} \right)^2 = 17,700 \text{ per square inch.}$$

$$17,700 \times 7.78 = 137,706 \text{ lbs.}$$

$$\text{Factor of safety } \frac{137,706}{56,520} = 2.43.$$

The area of section at the front end (minimum section of rod),

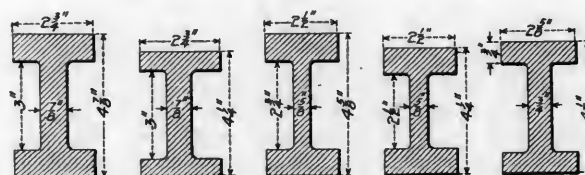


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

$$\text{Fig. 5, } = 6.07. \quad \frac{56,520}{6.07} = 9,311 \text{ lbs. per square inch to resist}$$

the direct push and pull of the piston, bending in last instance not considered. A number of engines using these rods have been in service for several years without any known breakages, although the stresses are somewhat higher than usual, more especially regarding the front end.

Another example is that of a main rod of a 20x24 inch ten-wheeler:

Steam pressure, 165 lbs. per square inch.

Section in center, as Fig. 6.

Moment of inertia = 2.49, axis perpendicular.

Area of section = 6.41.

Least radius of gyration = .623.

Length of rod between centers = 111¼ inches.

Thrust of piston, $20^2 \times .7854 \times 165 = 51,800$.

Material—Steel, of 70,000 to 80,000 lbs. tensile strength. Ultimate strength to resist bending sideways, axis perpendicular:

$$42,000 - .62 \left(\frac{1}{r} \right)^2 = 22,350 \text{ per square inch.}$$

$$22,350 \times 6.41 = 143,263 \text{ lbs.}$$

$$\text{Factor of safety } \frac{143,263}{51,800} = 2.76.$$

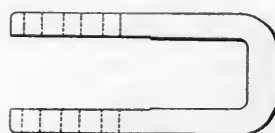


Fig. 9.



Fig. 10.

$$\text{Area of section at front end (minimum section of rod), Fig. 7, } = 5.94. \quad \frac{51,800}{5.94} = 8,720 \text{ lbs. per square inch to resist in direct}$$

push and pull of the piston. No breakages of these rods have occurred in five or six years.

Several breakages are recorded of main rods on eight-wheel engines after a year or less in service. They broke through the bolt holes on the line C—D, Fig. 2, with a stress of about 11,800 lbs. per square inch. The material was steel, with 70,000 to 80,000 lbs. tensile strength.

A third example is that of a main rod of an 18x26 inch ten-wheel engine:

Moment of inertia = 2.366.

Area of section = 6.19, Fig. 8.

Least radius of gyration, .618.

Length of rod between centers 108 inches.

Thrust of piston, $18^{\circ} \times .7854 \times 180 = 45,720$ lbs.

Material—A number of the engines were built with rods of hammered iron and others with rods of steel, 75,000 to 85,000 lbs. tensile strength.

Ultimate strength to resist buckling, per square inch of section, 23,230 steel, 20,830 hammered iron. Ultimate strength of steel rod = $23,230 \times 6.19 = 143,790$ lbs.

$$\text{Factor of safety} = \frac{143,790}{45,720} = 3.14.$$

Ultimate strength of hammered iron rod = $20,830 \times 6.19 = 128,930$ lbs.

$$\text{Factor of safety} = \frac{128,930}{45,720} = 2.8.$$

Area of section at front end = 5.81 square inches (minimum section of rod). $\frac{45,720}{5.81} = 7,870$ lbs. per square inch.

Stress at solid front end, see Fig. 1 (section through set screw hole); $\frac{45,720}{7,125} = 6,410$ lbs. per square inch.

For two or three years 50 or 60 engines using this main rod have been in service without any breakages.

Straps for the Front End.—Fig. 9 shows a form of steel strap used on a number of engines for several years without any breakages. The maximum stress is 8,175 lbs. per square inch (minimum section through the bolt holes). Two straps, made of steel from the same specifications, as in the preceding case, on different engines, broke after a few months' service through the keyways or bolt holes, at a nominal stress of 10,830 lbs. per square inch.

Another case is recorded of a hammered iron strap, Fig. 10, in which the nominal stress of the minimum section through the bolt holes was 12,170 lbs. per square inch. This strap broke through the corner where the stress was 7,000 lbs. per square inch after running for three years and four months. Probably this failure in the corner was caused by the improper design of the end or by injury to the metal in forging.

CAR FRAMING.

By C. A. Seley.

The paper and discussion by Mr. F. M. Whyte, Mechanical Engineer, C. & N. W. Ry., reported in the November proceedings of the Western Railway Club under the above title, and the editorial comment in the "American Engineer" (page 17, January, 1899), has doubtless interested those who have to do with the car question. The necessity for strengthening cars to carry increased loads due to the quite general desire to raise capacities, and on account of the structural weakness of many of the older designs, raises the question of how the increase of strength may be provided in the cheapest and most effective way. Doubtless this was the main object of the paper, although the theories are believed to be applicable to new designs.

There is apparently a basis for the belief that a light bolster can be favored by rearrangement of the truss rods and needle beams, but careful reading shows that this is applicable to special conditions that do not always obtain. To favor the bolster other parts must be strengthened at perhaps equal cost, and many will say: Put it where it belongs in the bolsters. All the stresses due to the lading, weight of the structure and the shocks of uneven rail come back to the bolsters, which constitute the foundation. The lading may be even or very un-

even, and the design should provide for all such variations. The framing must stand pulling and buffing strains, whether loaded or empty. Strengthening of old cars must be confined mainly to the bolsters, truss rods and needle beams, as a rearrangement of sills is generally impossible.

Wooden and steel car construction are two very different propositions, and it is to the former that Mr. Whyte's theories seem mainly applicable. The favorite idea in steel car design seems to be the strong back bone in the center, so arranged that the weight of the outer lading can be transmitted to it by suitable connections. This idea cannot be carried out in wooden cars. It is impossible to put in the width or depth of center sills that would make these members comparable with the fishback or deep girder construction possible with steel. We have therefore to resort to truss rods, and at once the problem changes. Most modern cars for miscellaneous traffic are from 36 to 40 feet long, and the distance from center to center of trucks is therefore 25 to 30 feet. There are many cars 45, 46, and in some extreme cases 50 feet long. The so-called sills of these cars are not sills as a matter of fact. Placed over supports the distance apart of their trucks they will hardly carry their own weight, and not even this without considerable deflection. No matter how many sills are put in the deflection is considerable unless they are supported by truss rods and cross sustaining timbers. These sills are then the chord of a truss; they become compression members and are only sills in sections as, for instance, between the needle beams and between the needle beams and bolsters, and they act as a cantilever or an end supported beam from the bolsters to the ends.

Leaders in car design tell us that full carrying strength for the loading should be provided in the lower frame, and that the house or superstructure should not be depended upon to carry any considerable part of the load, for with central side doors the upper framing is an incomplete truss, like a bridge truss with the center diagonals left out. This is undoubtedly the correct view of the matter, although the side sills are greatly stiffened by suitable upper framing except between the door posts, and therefore wooden cars of any considerable length must be provided with truss rods of sufficient strength to carry the load transmitted to the needle beams. The side sills have to carry the weight of the superstructure as well as a portion of the load, and are generally trussed, the rods transmitting their loads to the ends of the bolsters. If the side sills are not trussed the needle beams take the portion of the load transmitted to them by the side sills and carry it to the nearest truss rod, and thence the strain travels to the bolsters. This load measured at the bearing or queen post may be considerable, increased as it is by the lever arm over which it is carried. The spacing of the sills and the location of the truss rods may be such that the load will be transmitted very differently than is ordinarily supposed. This will be treated later on. According to the writer's observation most six-sill cars have the side and intermediate sills trussed, leaving the center sills untrussed. They are secured to the bolsters, and the needle beams take the same deflection as the other sills under the load, but are more free to take their proper duty in receiving the pulling and buffing strains. Some will say that more than four truss rods are preferable, and for large, wide cars more than six sills are needed. This, however, is a matter of opinion, and the writer does not favor more than six sills in any ordinary car, and would use a short sill over the needle beams to help support the floor in the doorways of wide cars. He would also prefer four heavy truss rods to a greater number of lighter ones, taking care to secure ample bearings for the end washers on the end sills.

In order to analyze the strains due to lading let us take a car 40 feet long inside, uniformly loaded, with the center of the transom five feet from the end inside, or a 36-foot car with a 4-foot 6-inch overhang, in either case the overhang being one-eighth of the total length. This one-eighth will balance the

same amount on the other side of the bolster, making one-quarter of the load to be transferred direct to each body bolster by the sills. This leaves one-half of the load to the needle beams to be brought back to the bolsters by the truss rods.

The accompanying illustration, Fig. 1, shows the arrangement of the sills and truss rods very commonly used, it being that of a car 8 feet 6 inches wide inside. The disposition of the load to the sills over the bolsters is shown as follows:

On each side sill.....	14%
" " intermediate sill	22%
" " center	14%
<hr/>	
50 × 2 = 100%	

The disposition of the load on the truss rods is arranged on the assumption that it is transmitted without deflection of the needle beams, and a more exact arrangement would be that given by calculating the concentrated load on each sill, and thence to the supports in relation to the position of the sills over the rods. The present arrangement will suffice, however, for the present purpose. The distribution gives:

Truss rod No. 1.....	15%
" " 2.....	35%
" " 3.....	35%
" " 4.....	15%
<hr/>	
100%	

Contrary to first thought, the outer rods are very lightly loaded, carrying less than half of the load of the inner pair. In actual practice, however, the weight of the superstructure, deflection of the needle beams and other reasons probably lessens the discrepancy, but it is a fact based on observation of the effects that inner truss rods give evidence of greater loading.

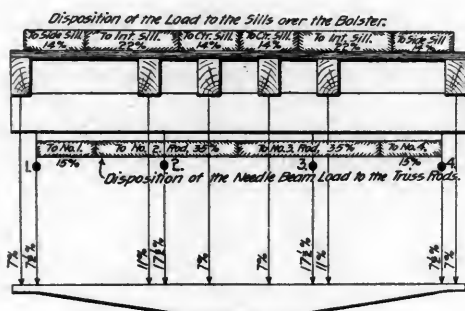


Fig. 1.

Car Framing. By C. A. Seley.

Referring again to Fig. 1, we may drop the load on each sill and rod to the bolster shown below (dividing each amount by two in order to make the total 100 per cent.) and see that the ends receive 14½ per cent. and that 71 per cent. is carried within 21 inches on each side of the center. Now remove the outer truss rod to the intermediate sills, as shown in Fig. 2, using rod positions Nos. 3, 4, 5 and 6, thus giving these sills a double support, which is brought to the center line of the sill by suitable arrangement of the queen posts. The needle beam load thus being carried at two points symmetrically arranged divides into two equal portions of 50 per cent. each. Dividing this by two and bringing it down to the bolster, adding it to the load on the intermediate sills over the bolsters, makes a total of 36 per cent. at the 21-inch point from the center, the load from side and center sills remaining the same as in Fig. 1. If the rods are moved still nearer the center by using the positions shown by rods 1, 2, 3 and 4 and the combined queen post as before, brings the truss load of 25 per cent. seven inches nearer the center, leaving all sill loads the same as in Fig. 1.

Thus it is plainly demonstrated that the nearer the center the more the bolster is favored. In the last named case half of the lading of the car is carried at points 14 inches from the center of the transom. It is done, however, at the expense of carrying 7 per cent. of the load, the amount transmitted to each end of the needle beams over a lever arm of 38 inches from weight to bearing. No ordinary needle beam could withstand the bending stress set up between the center sills by such a load. The

necessity for strengthening the needle beams is very apparent if for any reason it is necessary to put the load upon them in that way. It seems, however, wiser to add to the strength of the bolster if any change is made. A shallow bolster may often be strengthened by well designed filling in place of possibly a few little thimbles. Mr. C. A. Schroyer, Superintendent of the Car Department, Chicago & Northwestern Railway, has recently designed a very effective strengthener for weak bolsters (see "American Engineer" February, 1899, page 45) by using a secondary truss on the center sills supporting the bolsters at the side bearings under the intermediate sills. Figs. 1 and 2 both show that this is a very desirable point to strengthen, and that the center sill load can be most profitably increased, being directly over the center plates. Even though the secondary truss should have to pass over both intermediate and center sills in some constructions supporting the ends of the bolsters, those of slight depth can be economically strengthened. By closely locating the loads and stresses many old cars can be greatly strengthened and the way opened for solution of what has been quite a difficult problem.

WATERVILLE SHOPS—MAINE CENTRAL.

In 1887 the Maine Central erected a repair plant at Waterville, Me., to handle the rolling equipment of the road. These shops embrace the machine and erecting shop, blacksmith shop, boiler shop, passenger and freight erecting shop, mill and paint shop, all of the buildings of brick and well designed and located according to the requirements of the service at that time.

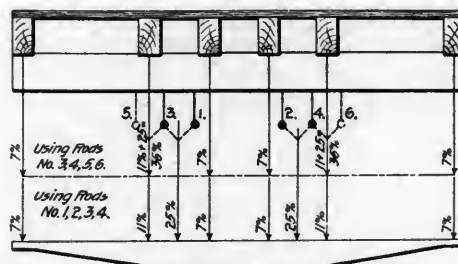


Fig. 2.

They are model shops now, notwithstanding the increase in size of power that has so recently entered as a disturbing element in the provision of facilities for keeping a locomotive in shape for economical road work. This they are doing with the 157 engines of all sorts and builds, besides taking care of their 4,400 cars, with an average force of 100 men in the motive power department, and an average of 140 men in the car department.

There are no specially occult processes of reaching results by Mr. Amos Pillsbury, Superintendent of Motive Power, but simply the old well known devices put to good uses and fostering an esprit de corps among the men that cannot help but influence the returns. The same spirit pervades the transportation department under the General Superintendent, Mr. Morris McDonald, one of the youngest officers holding such a position. He believes in Brown's methods of discipline, and says the right way to handle men is by the golden precept—"Be Fair."

Mr. William McIntosh, for many years Master Mechanic of the Chicago & North-Western Railway, at Winona, Minn., has been selected to succeed Mr. C. A. Thompson, who has just resigned as Superintendent of Motive Power of the Central of New Jersey. Mr. McIntosh has earned the distinction of being one of the best motive power officers of the Northwest, and his appointment is fitting, as he will bring a very wide and successful experience to his new position.

SOME CAST STEEL LOCOMOTIVE DETAILS.

Atchison, Topeka & Santa Fe Railway.

Mr. John Player, Superintendent of Machinery of the Atchison, Topeka and Santa Fe, has gone extensively into the merits of cast steel, and finds it so satisfactory in construction and in service that he is using it liberally in the construction of new

engine as the dome, and comprise the frame and jaws in one piece, the swing hangers, and the radius bar. The frame alone as shown in the engraving weighs 461 pounds, the hangers weigh 24 pounds each, and the radius bar weighs 238 pounds, all weights finished. Except the hangers, these details are not easy to make in the smith shop, even when in detached parts, as the frame is made when forged. Again, there is an opportunity for correct distribution of material in the cast product,

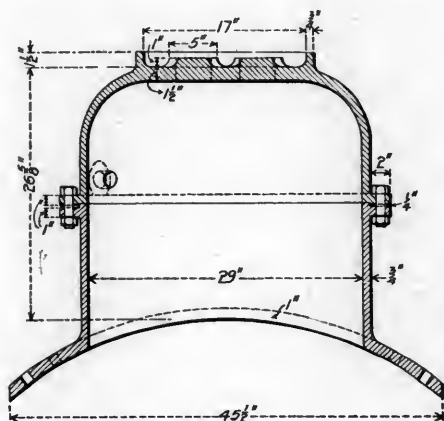


Fig. 1.—Steam Dome.

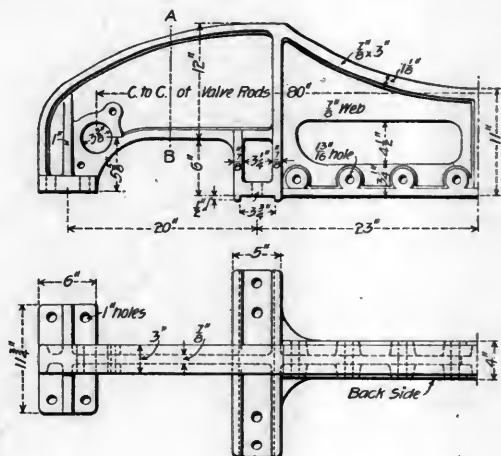


Fig. 3.—Guide Yoke.

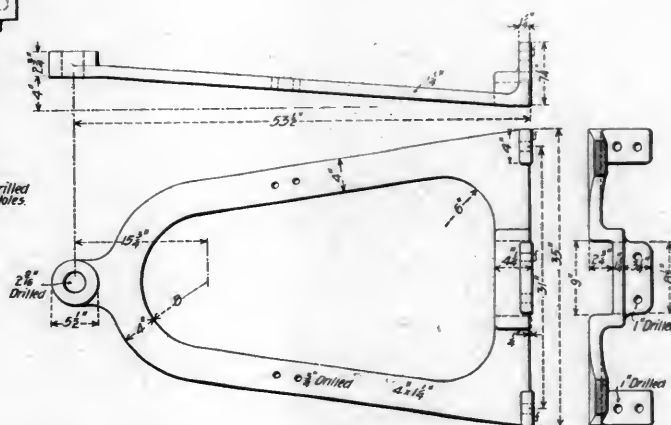
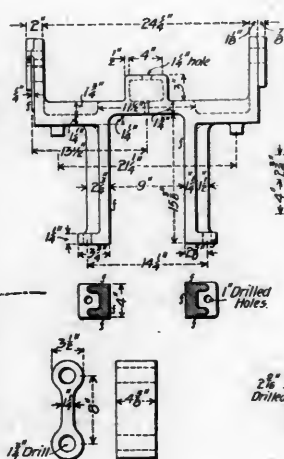
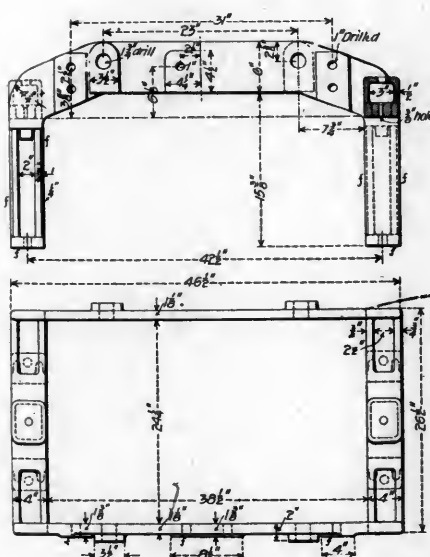
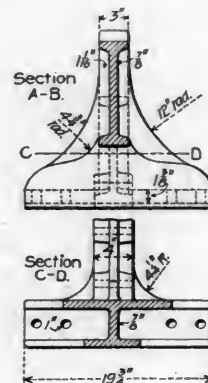


Fig. 2.—Locomotive Truck Details. Cast Steel. Atchison, Topeka & Santa Fe Ry.

MR. JOHN PLAYER, Superintendent Motive Power.

heavy engines. This material is to be used for the frames of twenty-five locomotives now building by the Baldwin Locomotive Works for this road, and we are informed that those already in service are entirely satisfactory. An experiment is now being made with cast steel steam domes, the construction of which is shown in Figure 1. This dome is used on a number of 21 by 28 inch consolidation engines, and it offers the advantage of giving ready access to the throttle valve and steam pipe. The dome is made in two parts, which are held together by flanges, bolted with $\frac{7}{8}$ inch bolts. The parting of the two sections is a little lower than the middle of the height and thus exposes the throttle so that it may be easily applied, removed or repaired. The body of the dome is $\frac{3}{4}$ inch thick, while the top is increased to $2\frac{1}{2}$ inches thick at the pop valve holes. The weight of this dome is 1,372 pounds, of which the upper section weighs 530 pounds.

The engine truck details, shown in Figure 2, are for the same

like ribbing, reinforcement and losses, which are impossible to make in a forging as cheaply as in a casting. This is also true of the guide yoke shown in Figure 3, which could not be forged in the form given to the casting. We have no figures for the weight of this part, but it shows a design apparently as light as is consistent with strength.

These parts are representative of those that Mr. Player makes in cast steel, but the drawings do not cover all of them, and we shall return to the subject in a future issue. We believe that there are 2,000 freight trucks having cast steel bolsters on this road, and not a single one has failed. There seems to be no hesitation on the part of the Atchison road to use cast steel on a score of unreliability.

"When the most conservative railroad running out of Boston adopts brick arches and single exhaust nozzles it is time to admit that something is settled and that the world moves."—F. W. Dean, before the New England Railroad Club.

INSPECTION AND CARE OF AIR BRAKES.

Lake Shore & Michigan Southern Railway.

The air brake has done so much to advance the interests of railroads that the care necessary to insure the good order of the equipment ought not to be given grudgingly, yet it is not evident that all roads are giving enough attention to this important part of maintenance. Through the courtesy of Mr. A. M. Waitt, General Master Car Builder, and Mr. H. F. Ball, General Car Inspector of the Lake Shore & Michigan Southern Railway, we are permitted to describe the practice of that road in inspecting and repairing air brakes at Buffalo. These efforts to increase efficiency of brakes are seen to produce immediate results, and are well worth what they cost, and they deserve to become more general.

The work of inspection, testing and repairing of the air brake equipment on cars for movement over the Lake Shore & Michigan Southern Railway from Buffalo, is performed after the cars are assembled into trains on the classification tracks. Ordinarily, the work is done by two men, both being competent air brake men, who are together able to inspect and care for about 300 cars per day under usual conditions. When a train is ready for inspection, connection is made at the front end with the yard line and the train is charged with air at 80 pounds pressure.

To expedite the work, very good results have been obtained by charging the train in sections of 10 or 15 cars, one man going ahead to release hand brakes, couple up the hose, and to properly set the handles of angle cocks, cut-out cocks, release valves and pressure retaining valves; the other man following to make examination for leaks and to repair them. When all is ready for test a service application of about 20 pounds reduction is made from the rear of the train, and the cars are again examined to see that the brakes have applied properly and that the piston travel is within the prescribed limits. When the repair work in conjunction with this examination is completed the brakes are released from the front end, and the cars again examined to see that all brakes have released.

In order that detention to trains on account of air brake work be kept down to a minimum, it is necessary that the work of inspection, testing and repairing be done in a systematic way. Material for repairs should be in close proximity to the different inspection tracks, the lighter material being carried with the men, to avoid unnecessary trips from one end of the train to the other. In all cases where cars require such extensive repairs to air brake equipment as to seriously delay the movement of the train through the yard, they are marked out and sent to the regular repair track, where they are taken care of by a separate repair force. It is the aim to allow no air brake cars to leave the yard with the air brakes cut out or inoperative. In exceptional cases, where the freight is of a perishable character, and the repairs to the air brakes would cause serious delay, cars are allowed to go forward bearing defective air brake cards.

An air pressure of 80 pounds is used in the test, in order to more readily discover weak and porous hose. A higher pressure was used at one time, but was unsatisfactory owing to the liability of cars leaving the yard with reservoirs charged too high, resulting subsequently in the dragging of brakes. The 80 pounds pressure is maintained uniformly by means of a reducing valve located between the main reservoir, which carries 100 pounds pressure, and the yard supply pipe.

From records at hand, a very marked reduction is shown in the number of air brake hose burst in trains which had received the yard test. Comparing the number of hose burst in trains which received the yard test with an equal number which did not receive the test, the ratio is about as 1 to 3. To some extent the difference may be accounted for in the greater efficiency of the men doing the air brake inspection; their inspection being more rigid than that of regular car inspectors, who have to look for other car defects equally im-

portant, if not more so. The yard test develops the fact that about 50 per cent. of the cars need attention in the way of renewals of gaskets, tightening up of leaky joints, renewals of hose, repairs to angle cocks, and cleaning of cylinders and triple valves, and oiling of cylinders. In some cases it is necessary to give the whole air brake equipment on a car a general overhauling, including the proper securing of the pipes to the car body, instead of their being suspended loosely by hangers that were never intended to keep them in one position. It has also been found necessary in a number of instances to thoroughly clean and repair the cylinders and triple valves of cars that had just previously gone through the owners' shop and had received general repairs, including repainting and lettering. Apparently all the attention given the cylinders and triple valves, while at the shop, was a new coat of paint.

Proper care is not at all times exercised by repair men in making air brake repairs, due in some instances to lack of proper tools. For example, in the application of gaskets to hose couplings, the lower edge of the gasket is being cut off, making a beveled edge, which permits the easy application of the gasket, but in a short time it requires renewing on account of leakage. By the use of a proper tool for removing the rust from the gasket seat in the coupling, the gasket may be easily applied, and will make an air-tight joint. In removing broken angle-cock handles, and replacing them with new ones, the angle cocks are oftentimes damaged, and left in leaky condition by the carelessness of repair men, or because of not having proper facilities for doing the work. The same criticism applies to other parts of the air brake equipment.

The experience thus far obtained emphasizes the necessity for similar plants at other large terminals, and is seen to be necessary for each road to take care of its proper proportion of the freight air brake equipment in use. By such distribution of the work each terminal will be able to maintain a higher standard of efficiency than is possible under present conditions. One of the most important items of repair work is the periodical cleaning of cylinders and triples. To properly look after this work each year, on a road having a large freight equipment, and to have it done with little delay to loaded cars in transit, means that advantage must be taken of each station where inspectors are located; to have such points furnished with proper tools, and a specific number of cars per month assigned to have cylinders and triples taken care of. By so doing, this work will not be congested at the large terminals and it will reduce detentions to loaded cars to a minimum. This idea is being carried out gradually on the Lake Shore & Michigan Southern Railway.

The men at all points were first given instructions in the air brake instruction car. Later, tools were furnished them from time to time for the proper performance of their work. At small stations, where air supply for testing is not available, hand pumps have been furnished. In this way the work at the large terminals will not be so great as to materially affect the prompt movement of loaded cars towards their destination. It should be the practice of all roads not to allow an empty air brake car to leave the shop or inspection station repair track without testing the brake, and cleaning the cylinders and triple valves, if they have not received attention in that respect within the proper time.

Under the topic, "A Consideration of the Best Arrangement of Air Testing Plants for Large Terminal Points," on page 72 of the proceedings of the Master Car Builders' Association for 1898, will be found a discussion by Mr. Ball, of the equipment needed for such a plant as is referred to in this description, the one described before the association being at Buffalo. This equipment includes a steam air compressor, with 8 by 8 inch steam and 1 1/4 by 8 and 9 by 8 inch air cylinders, a storage tank of 100 cubic feet capacity, a 2 inch main pipe connecting the storage reservoir to the 1 1/2 inch branch pipes extending along the repair and inspection tracks. Four lines of 1 1/4 inch pipes, with connections spaced 50 feet apart, complete the equipment for 6 repair tracks. In the inspection yard, 7 1/4 inch lines serve 14 inspection tracks, and connections for hose are furnished at 100-foot intervals.

ANTHRACITE COAL BURNING, NEW YORK, ONTARIO & WESTERN RAILWAY.

The location of the New York, Ontario & Western Railway through an anthracite coal region renders a large amount of "culm" available for fuel, and through the courtesy of Mr. Geo. W. West we have received drawings showing the arrangements of grates which have been found successful with this fuel.

Culm is fine refuse which has accumulated for years around the coal breakers, and it is very cheap. A great many experiments have been made with this fuel in stationary practice, and it has also been used to some extent in locomotives. The results of Mr. West's experiments have been to reduce the cost of fuel about one-half, and at the same time he has succeeded in arranging the grates so as to make the locomotives steam freely. We are informed that ten locomotives are now fitted to burn culm, a number having been changed for this purpose by the Cooke Locomotive & Machine Co.

A comparison made between an engine fitted to burn culm and another of almost exactly the same size of the older arrangement carried out for a period of two months showed the following results:

No.	Mileage.		Fuel Coal.		Lbs. per Mile.		Cost per Mile.	
	Engine	Car.	Lbs	Cost.	Engine.	Car.	Engine.	Car.
Culm, Engine 13...	1.372	4.258	98,596	26.88	71.8	23.1	1.958c	0.631c
Bitn's. Engine 77.	1.346	4.193	67,007	53.60	49.8	16.0	3.882c	1.276c

which were shallow at the sides, trouble was found in keeping the ashes clear, and a further objection was found in the necessity for using grates which were odd sizes. The division of the grate area into four sections permits of cleaning the fires very quickly, and also avoids trouble from ashes lodging in the upper sides and corners of the ash pan. Incidentally it is worth noting that the grate areas of the two types of locomotives shown are 71 and 80 square feet; the grates are 7 feet 6 inches by 9 feet 6 inches and 10 by 8 feet; the fire doors are elongated, and are 12 by 36 inches in size.

Mr. West has given us a statement of the cost of fuel per train mile and per car mile for the past ten years, as shown in the following table:

Year.	Cost per Train Mile. Cents.	Cost per Eng. Mile. Cents.	Cost per Car Mile. Cents.
1898.....	11.37	9.71	1.160
1890.....	11.57	9.56	1.105
1891.....	12.08	9.59	1.027
1892.....	11.79	9.33	.945
1893.....	11.64	9.13	.900
1894.....	10.84	8.62	.845
1895.....	9.74	7.61	.726
1896.....	8.81	6.83	.647
1897.....	8.59	6.72	.618
1898.....	8.46	6.56	.618

In 1889 there were 85 locomotives on the road, 71 of which were in service and using bituminous coal, except in the case of three engines which were using lump anthracite. At present the equipment includes 133 engines, with 110 in service, 67 of which have wide fireboxes burning anthracite coal.

A new process for making briquettes of petroleum refuse has been introduced in Germany. In this process about 10 per cent. of soda lye, with 10 per cent. of any other kind of fatty matter—tallow, for instance—is heated in a boiler, and 90 parts of petroleum refuse is added to the heated mass. This mixture is then heated, under constant stirring, for

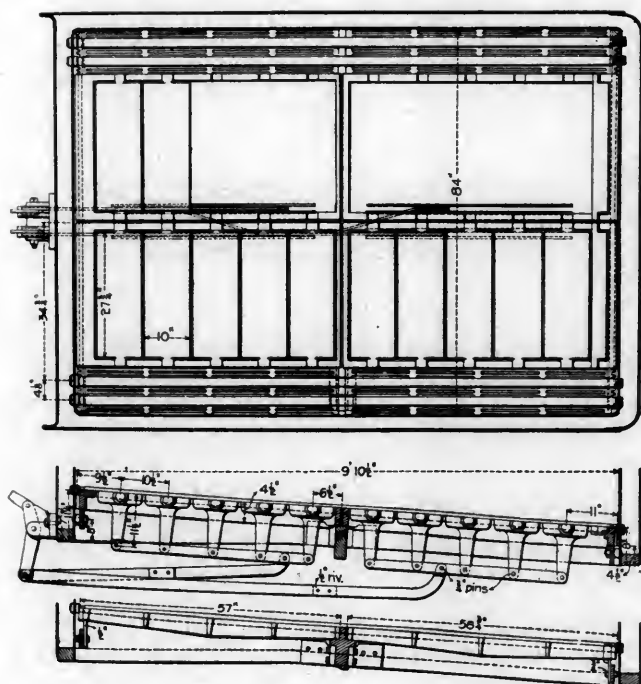


Fig. 1.

Anthracite Coal Burning—New York, Ontario & Western Railway.

MR. G. W. WEST, Superintendent of Motive Power.

The statements are not in terms of ton miles, but the figures appear to be comparable.

The arrangement of grates adopted is shown in Fig. 1. Fig. 2 shows the standard grate, and Figs. 3 and 4 present sections of the fire boxes, which are of the Wootten type, used with this fuel.

The arrangement of grates has been made a standard on the road, and Fig. 1 shows it to be a combination of shaking grates, stationary grates and water bars. The shaking grates are in four sections, divided by longitudinal and cross bearers. The standard grate shown in Fig. 2 is used in all sizes of fire boxes.

Mr. West, after trying a number of different combinations of grates and water bars, has found the one illustrated to be the most satisfactory. He first tried shaking grates, which were the full width of the fire box, but on account of the ash pans,

about an hour, care being taken to prevent the temperature reaching the boiling point of petroleum. In this incipient state of saponification the mass will take up large quantities of fluid rock oil, and if this incorporation proceeds too slowly or remains incomplete it may be hastened by adding a little soda lye. The mixture is run into molds and allowed to cool, when it may be cut into pieces of any desired form. Coal dust, sawdust, or other refuse may be added during the process of manufacture, according to the use for which the briquettes are destined, and if it should be desired to obtain a product of less consistency the grease may be entirely or partially replaced by resin, the product in either case having more than 80 per cent. of petroleum, more than 90 per cent. of combustible substances, and less than 5 per cent. of incombustible residue.—"Iron Age."

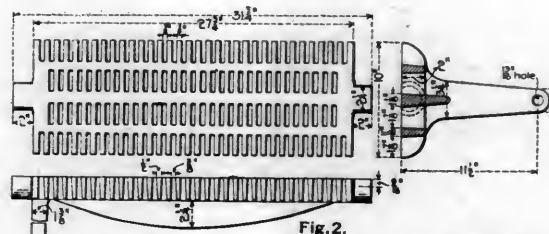


Fig. 2.

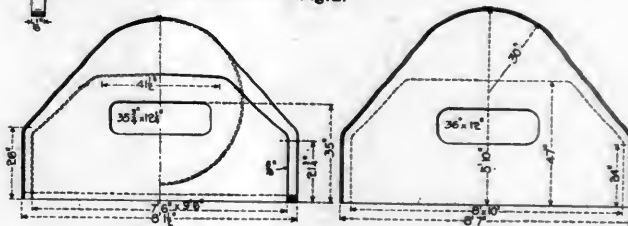
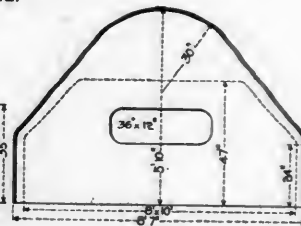


Fig. 3.



HEAT INSULATION OF LOCOMOTIVE BOILERS.

The losses from a locomotive boiler by the radiation of heat and the values of several different boiler coverings as insulating material have recently been investigated on the Chicago & Northwestern under the direction of Mr. Robert Quayle, Superintendent of Motive Power, and reported by him in a paper before the Western Railway Club. The tests were under the supervision of Mr. Waldo H. Marshall, Assistant Superintendent of Motive Power, who was assisted by Mr. F. M. Whyte, Mechanical Engineer of the company, while the manufacturers of the boiler coverings were represented by Prof. William F. M. Goss, of Purdue University, who formulated the results of the tests. The scheme of the tests, briefly, was to test the boiler of a standard eight-wheel engine with and without covering, and both running and standing, and base the efficiency of the various coverings on the amount of condensation. The boiler of the test engine was not fired up, but received steam from an engine coupled at the rear, which furnished the power and pushed the test engine over the road.

The test boiler had 0.61 of its total surface covered in the experiments on the coverings. The total surface includes all surface except that of the smoke box. The covering included the dome, cylindrical part of the boiler and the wagon top as far down as the top row of stay bolts, stopping at the cab, the boiler head and the side of the firebox were not covered. This amount of covering is that usually provided in common practice. The quantity of moisture in the covering was found to affect its efficiency, as would be expected. It was also found that cement coverings were very nearly equally as efficient as the others when thoroughly dry. The thickness of covering was found to have an important influence on its efficiency; that is, that which showed 62 per cent. efficiency could be made to give 64 or 65 per cent., or more, by increasing its thickness. This 62 per cent. represents the proportion of saving of all the heat radiated from the same boiler when uncovered, the saving being due to the covering of 61 per cent. of the exterior surface.

That the power loss from radiation is a considerable one in the unprotected boiler and worthy of consideration in the covered boiler is seen by the table giving results under both conditions:

Power Lost by Radiation.

	Horse-power equivalent to radiation losses.
Bare boiler—	
Locomotive at rest.....	12.
Locomotive running 28.3 miles per hour.....	25.
Covered boiler—	
Locomotive at rest.....	4.5
Locomotive running 28.3 miles per hour.....	9.

It is gathered from these results that even when a boiler is well covered the loss in power from radiation when standing is at the rate of 4.5 horse power when the boiler pressure is 150 pounds, as during these experiments, the loss increasing as the boiler pressure is increased, the temperature of the atmosphere reduced or the engine is put in motion.

The following statement of the cost of this radiation will let in some light that will be likely to attract attention to the desirability of its prevention as far as possible:

Cost of Radiation—Uncovered Boiler.

Pounds of coal per hour equivalent to radiation losses, assuming evaporation from and at 212 deg. F. of 6 lbs. of water per pound of coal—	
When standing.....	60
When running 28.3 miles per hour.....	126
Tons of coal per month, assuming boiler to be under steam standing 200 hours, and running 28.3 miles per hour during 300 hours per month.....	25
Cost of radiation per year for boiler tested, assuming the conditions of the preceding paragraph and assuming the price of coal \$2.00 per ton.....	\$600

These figures of course have application to a bare boiler only, a condition approached, but never quite reached, by the poorest wood lagging. The annual saving which would be realized by the efficiency of 62.3 per cent. would, therefore, be $\$600 \times 0.623 = \383.80 . It is shown that an increase in efficiency in covering by 1 per cent. will give a saving of \$6 a year; an increase of 2 per cent., \$12, and 3 per cent., \$18, all as shown by the engine tested and under the conditions of the test. The close agreement in uniformity in the results obtained by the different coverings is a matter that will occasion some comment, for the reason that the contrary has been the general supposition; or, in other words, that there was a wide variation in

efficiency. There is one point, however, not brought out in the tests, and necessarily impossible under the conditions; namely, the effect on efficiency of a boiler covering by age or long service.

The records of the various coverings is as follows:

	Pounds of Steam Condensation per Minute.									
Standing test.....	A	B	C	D ₁	D ₂	E	F ₁	F ₂	G	
Running test.....	6.78	2.63	3.42	2.91	2.86	3.52	3.04	3.22	3.03	
(Speed, 28.3 miles).....	14.27	5.68	5.47	5.03	5.34	5.21	5.29	5.30	5.70	

While the reference letters were not identified in the paper or by the manufacturers in the discussion, the following is believed to be a good guess at the various names:

A is the bare boiler, B the plastic cement covering, Salt Mountain asbestos, used by the Chicago & Northwestern, and the others are believed to be: C, asbestos fire belt; D₁ and D₂, the asbestos sponge felt lagging, these three being made by the H. W. Johns Co.; E, the lagging made by the Chicago Fireproof Covering Co.; F₁ and F₂, and G must be the product of the Keasbey & Mattison Co., and the Franklin Manufacturing Co. The first two are probably the Keasbey & Mattison magnesia blocks, and G we believe to be magnesia blocks by the Franklin Manufacturing Co.

The economy possible of attainment by means of a good boiler covering, as shown in these tests, is certain to lead to renewed efforts by all interested, and at the same time there will no doubt be experiments made to determine the effect of covering other exposed surfaces aside from those in the case noted, say, for example, the cylinders and saddle. If insulation is a good thing to prevent radiation of heat from a boiler, is it not equally as good to prevent loss of heat from the cylinders and prevent condenser action therein? It is probably far more expensive to lose heat in the cylinders and steam passages than in the boiler because of the wastefulness of cylinder condensation in the use of steam. Here the loss is effective in reducing the power of the cylinders.

HYDRAULIC FORGING MACHINE.

Juniata Shops, Pennsylvania Railroad.

The advantages of hydraulic forging presses over hammer work in locomotive forgings were pointed out by Mr. T. R. Browne in his article on the blacksmith shop, on page 188 of our June, 1898, issue, and we now present engravings of a press for small work, which has been in use in the Juniata shops for some time, and is an example of the compactness and convenience of such a machine.

This machine, when working under hydraulic pressure of 1,500 lbs. per square inch, has a capacity of 30 tons, or about 5 tons per square inch of available die surface, this being sufficient for compression of steel under favorable heats. It was originally designed for making switch rod and brake jaws, and with this object in view the dies, instead of being the ordinary 6 inch square blocks, are 6 by 6 by 9 inch pieces. It was soon found that in addition to the class of work mentioned nearly all of the varieties of special upsetting in connection with bolts could be done, and also the manufacture of track and shop wrenches from the straight bar.

The machine has a main ramming cylinder and a gripping cylinder. The stroke of the main cylinder is limited by a screw adjustment, and both cylinders have automatic pull-backs, both of which are illustrated in the sectional views, that of the main cylinder being enlarged to show its construction more clearly. The operating valve shown in Fig. 1 is so constructed that in starting up the machine the gripping cylinder operates its ram first, gripping the work, and the main ram follows. In the reverse operation the main ram retreats first and the gripping ram afterward.

This machine has sufficient capacity to upset and form hand rail columns complete, as well as a variety of similar work, and it has been found particularly successful in certain intricate shapes which it is desired to finish in a single heat, this being chiefly due to the fact that the speed of the ram is sufficiently slow to permit the metal to flow. It has been found that work in several difficult cases which could not be done with the usual speed of the ram was successfully formed when the speed was reduced, and this experience seems to indicate the necessity for being able to adjust the speed to the different kinds of work.

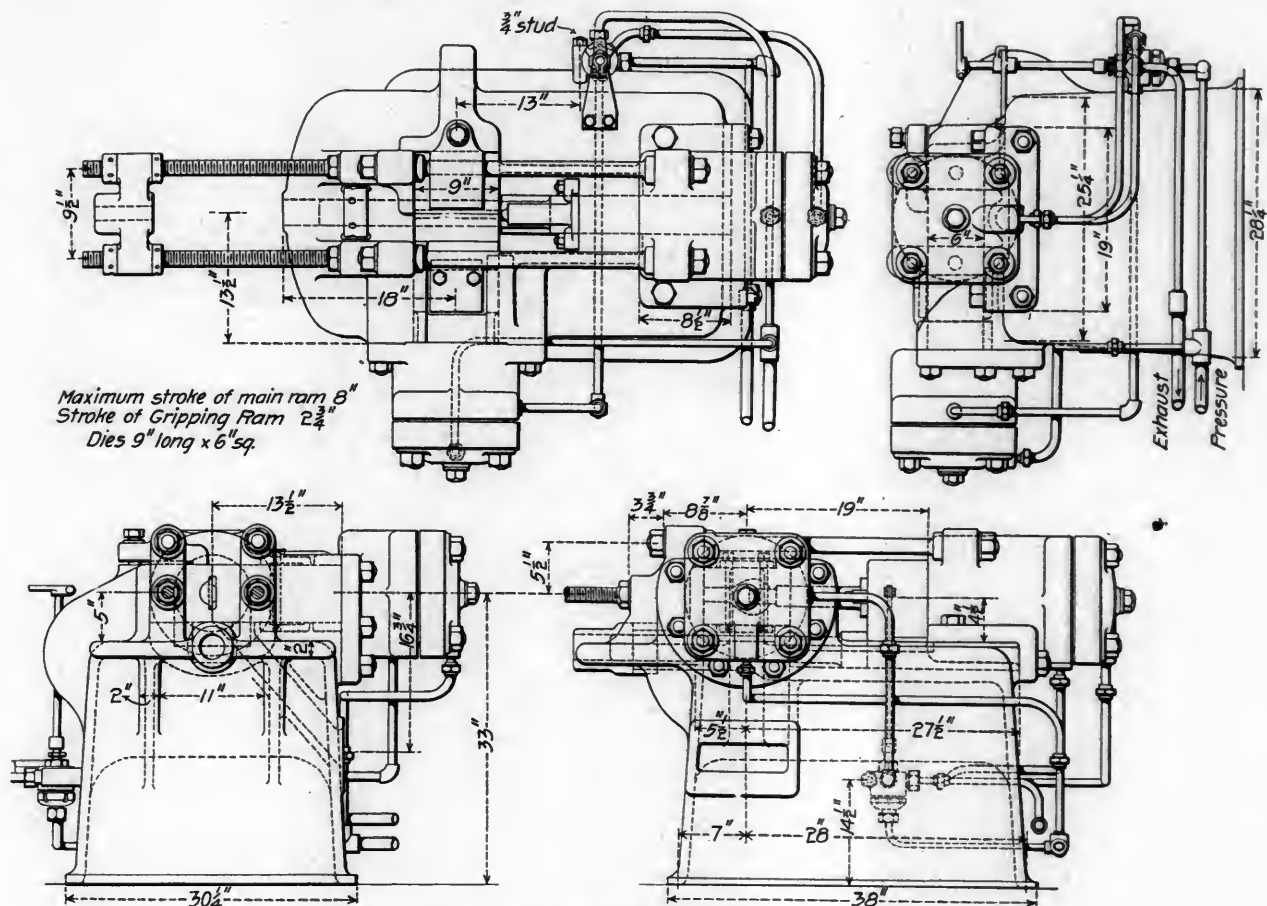


Fig. 1.—Plan and Elevations of Machine.

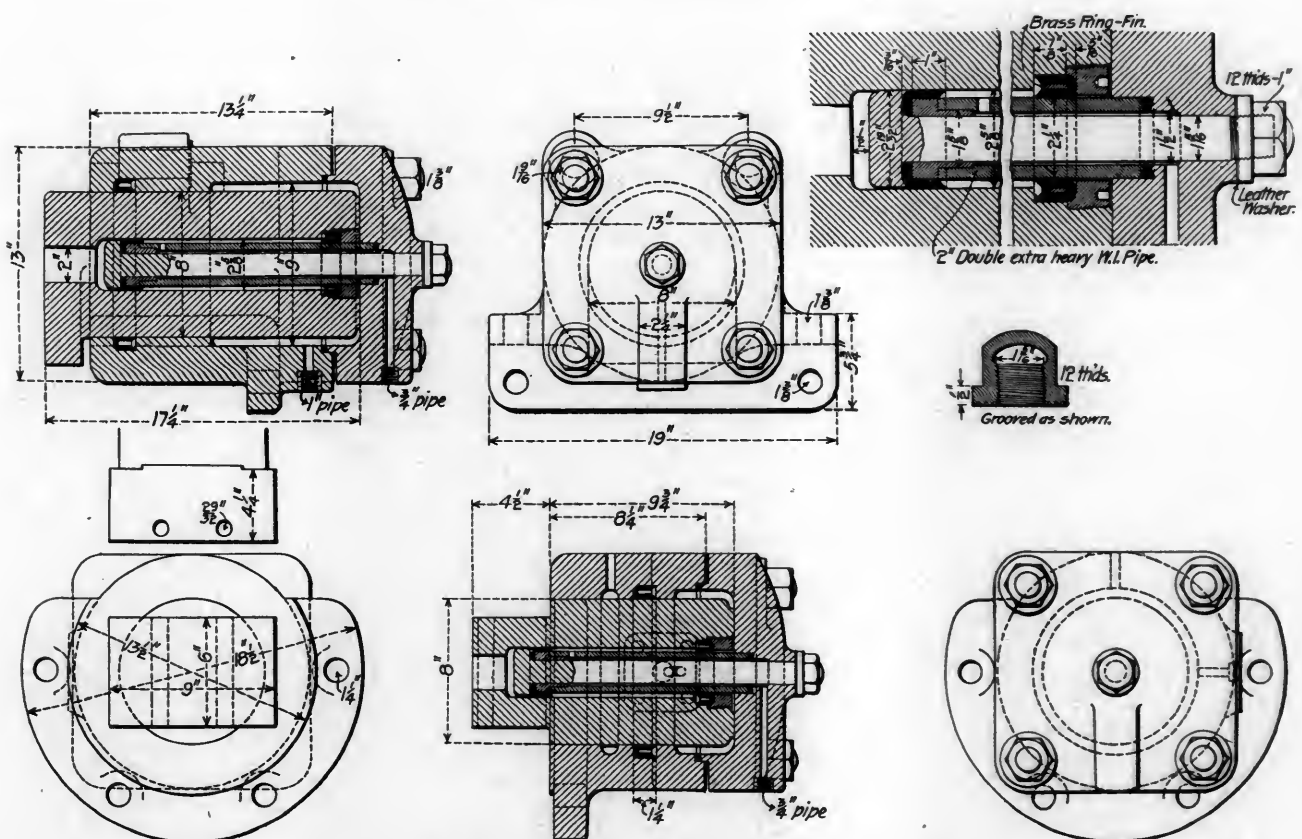


Fig. 2.—Sections of Cylinders and Pull Backs, Hydraulic Forging Machine.—Juniata Shops, Pennsylvania Railroad.

CYLINDER RATIOS FOR COMPOUND ENGINES.

Custom and precedent in compound engine practice have usually confined the cylinder ratios between comparatively narrow limits, which are about as follows: Ratios of 1 to 2.75 and 1 to 3.25 in European stationary practice, 1 to 3 and 1 to 4 in similar practice in America and England, while compound locomotives are usually made between limits of 1 to 2.5 and 1 to 3. A common rule in stationary practice has been to make the diameter of the low pressure cylinder 2 inches less than twice the diameter of the high pressure cylinder.

The question of the correctness of these limits has been boldly and consistently presented by Mr. George I. Rockwood, who expressed his views in our columns in 1891 in an article entitled "How Many Cylinders Will It Pay to Introduce in the Multi-Cylinder Engine?" That article was written before the author had the support of experimental results for his views, and he has recently advocated the unusual ratios of 1 to 8 in a paper read before the Providence Association of Mechanical Engineers, a complete report of which may be found in "The Engineering Record" of January 7, 1899. Mr. Rockwood goes farther than that, and believes that the intermediate cylinders of triple expansion engines are better omitted. He says:

"For stationary power plant engines the most economical engine at present practically possible, all things considered, is, in my judgment, a cross compound engine, working with a boiler pressure of 180 lbs., a vacuum of 13½ lbs., a receiver pressure of 8 lbs. and a cylinder ratio of 8 to 1."

He also says:

"I believe * * * that a pumping engine of largest size, working with practically no clearance, with steam at a boiler pressure of 180 lbs. and a cylinder ratio of 8 to 1 would give the horse-power on a consumption of less than 11 lbs. of steam and a coal consumption of 1 lb. per horse-power hour."

The explanation of the proportions selected for usual practice is that an engine so proportioned reduces the "drop" of pressure from the end of expansion in the small cylinder to the cut-off pressure in the large cylinder to the minimum, and at the same time gives reasonable ratios of expansion in each. In other words, the "drop" is considered a most serious loss, and great pains are taken to avoid it. Mr. Rockwood, however, shows that there are two reasons for "drop," and believes that advantages accompany moderate use of it. He incidentally points to the increase in steam pressures which have come into use during the 30 years of efforts to reduce "drop," and says that we know high ratios and high pressures are more economical than low ratios and low pressures. No foundation is found for the supposed error in permitting "drop" in the receiver of a compound engine, but while it is always wasteful, such waste should not be a controlling factor in the determination of ratios.

Clearance is believed to be "the chief cause of preventable waste," but intermediate receivers should not be associated in the same category with clearance spaces.

The two causes for drop are: (1) "Intermediate expansion," i. e., when more steam by volume leaves the receiver than is put into it per stroke (presupposing that no steam is either made or condensed in the receiver itself), and (2) cylinder condensation and clearance in the low pressure cylinder. "Drop" may be prevented by adjusting the cut-off. The cut-off may be either a corrective or a cause of "drop," and if adjusted to prevent it a great deal of cylinder condensation may result. On the other hand, experiments on the Sibley College laboratory engine have shown that "drop" acts to improve the quality of the steam and prevent initial condensation in the low pressure cylinder. This shows a gain by "drop," considered thermally, and there is another gain from the fact that the use of considerable drop permits the use of wide variations in the cut-off in the second cylinder without looking at the end of expansion in that cylinder or materially reducing the receiver pressure.

Mr. Rockwood's position might be considered a radical one were it not supported by practical experience in the form of

25,000 horse-power in eight large compound condensing engines built with the ratios he recommends. These were sold under a guarantee to work with an economy of 12½ lbs. of dry steam per horse-power per hour, and the guarantee was in all cases surpassed. One of these engines is referred to by the author of the paper in the following quotation:

"The very best performance of any mill engine which has been tested by recognized and competent experts is one of this type running at the mills of the Grosvenordale Company and tested by Mr. Barrus, who published his report in "The Engineering Record" of November 20, 1897. The steam consumption was 11.89 lbs. total per indicated horse-power hour, and the coal consumption was 1.18 lbs."

In tests comparing a triple expansion engine and a compound, with Mr. Rockwood's ratio, at Sibley College, reported in the "Transactions" of the American Society of Mechanical Engineers, Vol. XIX., it was shown that the compound did as well as the triple on heavy loads and better on light ones.

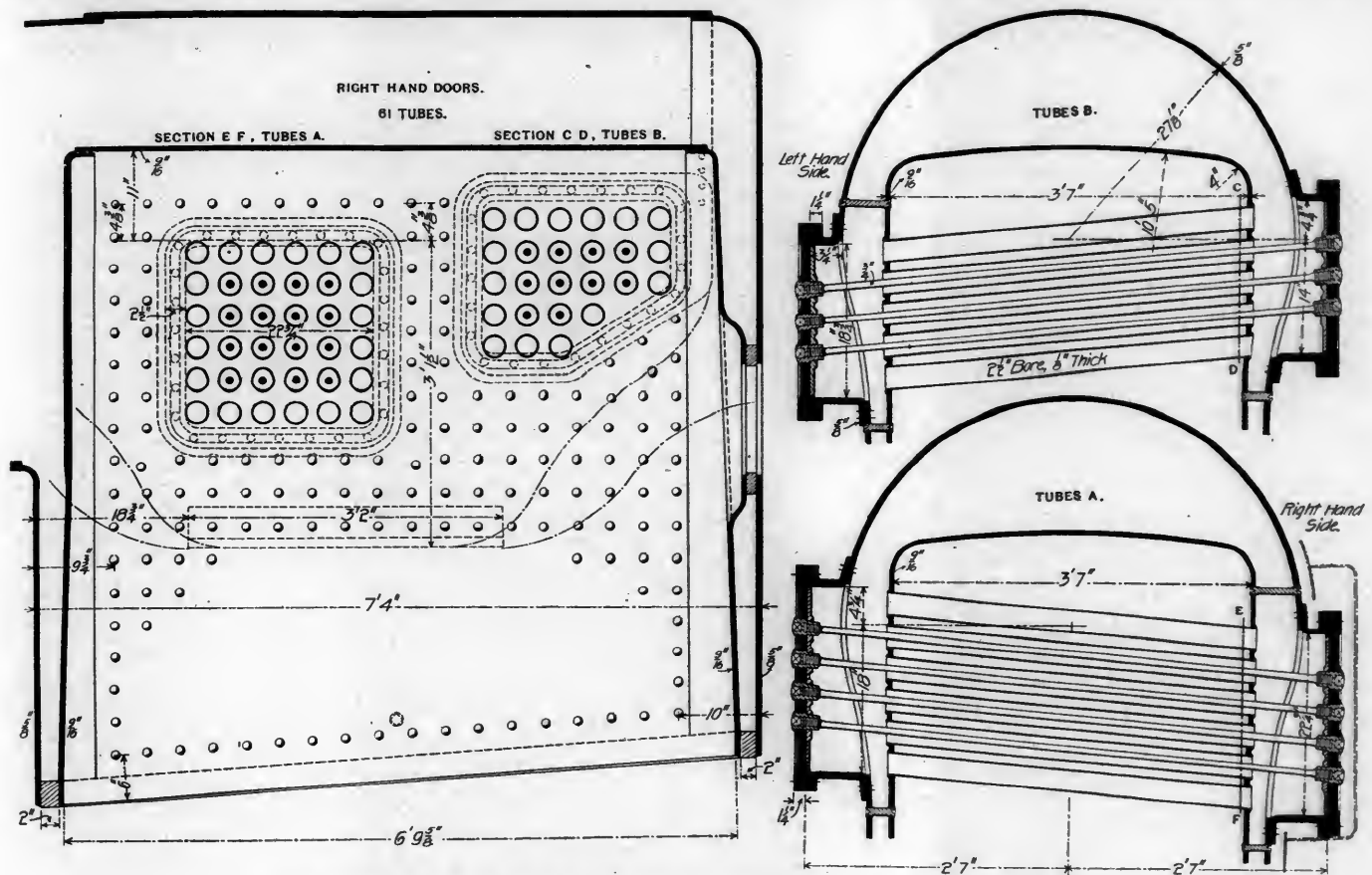
Mr. Rockwood says that these experiments at all events make it perfectly plain that cylinder condensation does not depend directly and solely on the range in the temperature of the steam, and that the extent of the surface exposed and the amount of "drop" that is allowed has at least as much to do with it.

WATER TUBES IN LOCOMOTIVE FIREBOXES.

London & South Western Railway.

If the water tube principle can be adapted to torpedo boat boilers, which offer some of the very severe conditions which exist in locomotive practice, there are grounds for hope that the advantages offered by this type may be available to locomotive designers. Water tubes have been used some years for supporting fire-brick arches in locomotive fireboxes, and the superior value of the relatively small amount of this kind of heating surface is everywhere admitted. An extension of the same idea, carried out in practice on the London & South Western Railway, from designs by Mr. D. Drummond, Locomotive Superintendent of that road, is shown by courtesy of Mr. Drummond in the accompanying engraving. Attempts have already been made in the United States to use water tube boilers, but nothing, so far as we can recall, has been done practically in the way of combining water tubes with the usual features of locomotive boilers. Mr. Drummond uses two nests of transverse tubes, in this case 2½ inch, across the firebox, the groups being inclined in opposite directions, as indicated. These tubes add about 160 square feet of firebox heating surface to this particular boiler, and the designer says that they produce a rapid water circulation in the space between the internal and external firebox sheets where the absence of active circulation has hitherto been one of the outstanding defects of the locomotive boiler. Access doors or man-holes are provided at each side of the firebox opposite the ends of the tubes for the purpose of examination and repairs. The firebox shown in the drawing is 6 feet 5 inches long by 3 feet 7 inches wide inside and 6 feet 6 inches deep.

In the case of a firebox with outside dimensions 8 feet 4 inches by 4 feet 6½ inches, the tubes add 215 square feet to the heating surface, or 13 per cent. of the total heating surface is in the form of water tubes, while 21 per cent. of the total heating surface of a boiler of this size is in the firebox. The boiler referred to in this paragraph is small when compared with American practice, but it is interesting to note that three nests of these tubes which might be placed in a firebox of the size of the Great Northern 10-wheel passenger engine illustrated in the "American Engineer" issue of October, 1898, page 328, would add about 350 square feet of firebox heating surface in the form indicated in the sketch. The total heating surface of the Great Northern boiler as it stands is 2,677 square feet, which might be raised to 3,025 square feet by this arrangement, the additional weight of the tubes being



Adaptation of Water Tubes to Fireboxes—London & South Western Railway.

MR. D. DRUMMOND, Locomotive Superintendent.

but 1,649 pounds, and the total increase of weight, not including the water in the tubes, probably about 2,500 pounds.

Mr. Drummond uses 24 tubes in the rear nest and 36 in the forward one. Stay rods are carried across the firebox through 10 of the tubes of the rear nest and through 16 of the other group. These are secured by adjustable right and left hand threaded nuts screwed through the cover plates and over the rod ends, while the plates are secured also by studs to the cast steel union pieces. The tubes are straight and short. They should be easy to clean, and with these lengths there will probably be no trouble from expansion. The stay rods

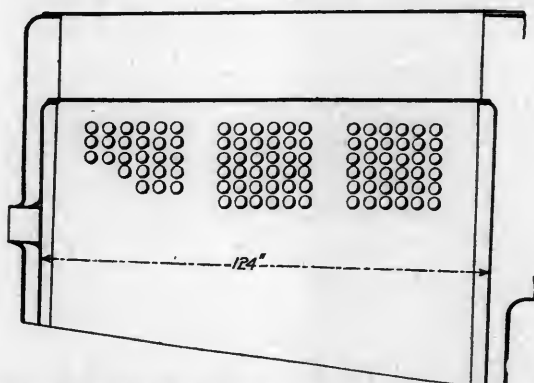
in view of the fact that passenger locomotives are now being designed with tubes 16 feet long.

It would be easy to put in too many of these tubes for boilers using bad waters owing to the difficulty of getting at the ends of the main body of boiler tubes in order to keep them tight by caulking, and there is also danger of putting in so many as to bring the bottom rows so low with relation to the grates as to quench the flames before combustion is completed, but it appears to be possible to secure a material increase of heating surface without going too far in either of these directions.

TABLE OF PISTON PRESSURES.

The following table was unintentionally omitted from one of Mr. Cole's articles on "Working Stresses of Materials." The table gives piston pressures on cylinders from 7 to 24 inches, inclusive, at boiler pressures of 160, 180 and 200 pounds, and will be found useful in computing stresses in piston rods, crank pins, side and also main rods and driving axles, as far as piston pressure is concerned in the strength of the two latter details. It is thus seen that the little table is of considerable scope in finding stresses in the parts subjected to forces transmitted through the piston, and, while simple in itself, will save time and calculation:

Diameter of Cylinder.	Area.	Piston Pressures.		
		Steam Pressure		
		160 lbs.	180 lbs.	200 lbs.
7	38.6	6160	6990	7700
8	50.3	8048	9064	10000
9	63.6	10170	11448	12720
10	78.5	12560	14190	15700
11	95.0	15200	17100	19000
12	113	18080	20340	22600
13	133	21280	23940	26600
14	154	24640	27720	30800
15	177	28320	31860	35400
16	201	32160	36180	40200
17	227	36320	40860	45400
18	254	40800	45720	50800
19	283	45280	50940	56600
20	314	50240	56520	62800
21	346	55360	62280	69200
22	380	60800	68400	76000
23	415	66400	74700	83000
24	452	72320	81360	90400



Showing Possible Adaptation to an American Locomotive.

are not exposed to the fire, and they are so disposed as to act favorably in supporting the flat cover plates.

The unmistakable support of water tube boilers by Engineer in Chief Melville of the United States Navy furnishes additional grounds for viewing this type of boilers with favor and with the substantial endorsement of Mr. Drummond's adaptation the subject of water tubes seems worthy of more than passing notice. We think it worthy of a trial, especially

COMMUNICATIONS.

POWERFUL PASSENGER LOCOMOTIVES FOR FAST TRAINS.

Editor American Engineer:

Your article on powerful passenger locomotives for fast trains on page 52 of current issue is most interesting, but at the same time, I do not think that it should cause much surprise among those who have studied carefully the questions presented. When you state that the especial points to be observed are "large boilers, large and direct steam passages, easily moving valves," etc., etc., you hit the nail squarely on the head, as every one of these points is a telling factor in the final result. I think that this is well understood as a general proposition, but it is possible that the exact reasons "why" may not be entirely clear.

It has often been stated that the old style of light valve gears allowed so much spring in the parts, that at high speeds, the ports would barely open. The more solid construction of the present day, in addition to the balancing of valves, has done much to overcome this trouble, and we believe that the piston type of valve is by long odds the most progressive and satisfactory. Another advantage is the long ports obtained with a moderate-sized valve. As an instance, the original Purdue experiments, when Prof. Goss found the "critical speed," or speed of maximum power to be about 200 revolutions per minute, were conducted with an engine having ports 16 inches long for a 17 by 24 inch cylinder, whereas in the recent tests of Prof. Smart the ports were approximately 18 inches long for cylinders 9½ and 16 inches by 18 inches long. The immense advantage of the latter in ports alone will be seen at once.

In 1896, when a committee of the Master Mechanics' Association (of which the writer was chairman), investigated the effect of the Allen valve at the Purdue Laboratory, the value of long ports was very readily seen, as will be apparent to any one who will examine Plate 16 (opposite page, 186), in the Proceedings for that year. These results frequently showed over 50 per cent. increase in mean effective pressure for the Allen valve at high speeds and short cut-offs. The following year, in reporting on cylinder ratios, the question was still further investigated, and diagram No. 3 on page 197 of the "American Engineer" for June, 1898, shows that at high speeds a great advantage is gained in having long ports.

Now, if these improved valves and ports admit more steam into the cylinders, they will evidently need a more plentiful supply of steam, hence the large boiler is a necessary accompaniment of the better valve. Where the curve at a given cut-off falls, as in the Purdue simple locomotive, it signifies that the valves will not admit all the steam which the boiler can deliver, but should this curve at some speed become horizontal and remain so, it would indicate that the capacity of the boiler, or steam pipes, had been reached. Where the curve always rises, as far as the experiments go, it shows that the capacity of the boiler has not been reached. Now, a compound locomotive, not using as much steam per I. H. P. will evidently not reach the limit of boiler capacity as quickly. We think that this, and the larger port openings, as illustrated by Fig. 1 (page 52, "American Engineer," February, 1899), considered in the light of the above, will explain the point under discussion.

In one way the several diagrams given in your editorial are misleading; the origin does not commence at zero as it should to give a perfectly clear idea of the exact nature and relation of the curves to each other. Prof. Smart speaks of this in his letter of Jan. 18, 1899, and also of the valves of the simple engine not admitting the full amount of steam. For instance, Fig. 3 at first sight gives the impression that the mean effective pressure for engine 1027 was constant at all speeds, but if the origin were extended to zero, where it belongs, it would be found that the locus curved downward to meet the origin. This shows a slightly falling mean effective pressure with increases in speed, and is in accordance with the diagram above referred to in the June number. Some diagrams prepared by the writer and presented on page 63 of the "Railroad Gazette" of Jan. 27 show the same divergence in the power curves as in Fig. 3, and these were prepared theoretically by assuming different lengths of ports. Tangents to these curves at points of high speed would intersect as in Fig. 3, but these should be really curves, as they must both start from zero. Several isolated points shown near the lower left hand portion confirm this assertion.

Following up our analogy, we therefore conclude that the di-

vergence in the curves shown in Fig. 3 is due to the different relative proportions of ports and cylinders, and possibly to different sizes of drivers, as the speed is expressed in miles per hour, instead of revolutions. Of course it is assumed that in neither case has the capacity of the boiler been approached, for then under all circumstances, the curve of power must approximate to a horizontal line. The four-cylinder compound evidently gives the advantage of long ports and moderate sized cylinders, and we think this an advantage which should not be underestimated, as intended to be shown by diagram No. 3, but in the absence of specific details as to the proportions of the single expansion engine, it is impossible to say just what Fig. 3 does represent. With the units in which the co-ordinates are shown, a great number of curves could be drawn, all giving different angles, by simply varying the size of the cylinders.

G. R. HENDERSON,

Mechanical Engineer.

Norfolk & Western Railway.
Roanoke, Va., Feb. 8, 1899.

AIR BRAKES ON HEAVY CARS.

The Lake Shore and Michigan Southern Railway Co.
Car Department.
Cleveland, O., Feb. 9, 1899.

Editor "American Engineer:"

I am interested in your editorial on page 50 of the February number.

It is quite difficult to decide what is the best method of procedure with regard to air brakes in heavy capacity cars. There is no question that a great deal of inefficiency in air brakes on trains can be overcome, if the air brake apparatus was not abused by being neglected, both as to adjustment and cleaning. There is no doubt that it is desirable to have a car which weighs 36,000 lbs. and carries 110,000 lbs. of lading, with means for providing a greater braking power than 70 per cent. of the light weight of the car.

I have thought that it would not introduce unnecessary and impractical complications if the air brake people should devise a means of throwing additional pressure into the cylinder when these heavy capacity cars are loaded up—such extra pressure being restricted when the cars are running light. It is not found impractical on mountain roads to use the retaining valve—the trainmen being held responsible for properly turning the valve when the cars are going to run down long and heavy grades. It would seem to my mind perfectly practical to have a valve (which might be called a brake reinforcing valve), located on heavy capacity cars, which should be so connected with the air supply as to restrict the amount of pressure that should be admitted into the cylinder when the cars are running light, and should allow the full amount of pressure to go in when the cars are running heavy. Such cars could be equipped with a cylinder of large diameter, so that with a low pressure of air admitted into the cylinder they would give the ordinary 70 per cent. of braking power, and with the full 70 lb. pressure admitted they would have a considerably increased braking power. Such a valve would be something in the form of a reducing valve—the handle when turned in one direction allowing the air to go through the reducing valve and be reduced to a proper point. and when the handle was turned in the other direction it would allow a direct connection between the auxiliary reservoir and the cylinder.

As to slack adjusters, doubtless they would from one point of view be a desirable acquisition to a car. They add, however, considerably to the expense if a road is buying 500 or 1,000 cars. There is, I think, a serious objection to putting on too many automatic devices on a railroad, whether it be in the form of signals, self-locking switches, or automatic slack adjusters. With all of these improvements there is a tendency for the personal factor to be lost sight of, and unless the men are held responsible for the proper working of mechanisms, and attention called to the duties which they would be expected to perform if the automatic devices were not in use, they are apt soon to neglect these matters and consider that the automatic devices can be depended on always to do the work that formerly they had to do. When such a condition exists there is liable to be an unexpected accident at some time, in which case the newspapers have occasion to make the statement that "the automatic device did not work," whereas if the devices applied to the equipment had been properly looked after by the men, and they had assumed that they were to exercise the same vigilance as they would if the special device had been absent, no accident would have hap-

pened. I think a conservative position in connection with such devices is a wise one. Many of the automatic devices in use are blamed for faults that would not exist if it were not for the fact that the companies using them allow their employees to depend on the automatic features and neglect the proper inspection and care of the apparatus. This condition is, perhaps, most forcibly illustrated by the conditions developing in the M. C. B. automatic coupler, due to lack of proper inspection and maintenance.

Returning to the subject of air brakes on cars of large capacity, I think that a field is now opened up which calls for ingenuity, and the bringing out of some simple device which—with the co-operation of the trainmen—will enable the roads to make the braking power of loaded, heavy capacity cars, more nearly in line with what it is on the present light capacity cars.

A. M. WAITT,

General Master Car Builder,

Lake Shore & Michigan Southern Ry.

Cleveland, Ohio.

February 9, 1899.

Editor "American Engineer":

Your editorial in the February number, page 50, entitled "Air Brakes on Cars of Large Capacity," calls attention to a matter which needs more general consideration than it has heretofore received.

While the capacity of the new 80,000 and 100,000-pound cars is an increase of from one-third to two-thirds above the 60,000-pound cars, the light weight of the new cars has not been correspondingly increased, and as the braking power is proportional to the light weight, the result is that these cars, when loaded, are braked to a lower percentage than the 60,000-pound cars.

When trains are made up exclusively of these large capacity cars, as is the custom on some of the principal coal and ore lines on which they have been adopted, this reduction in the percentage of braked weight makes no difference in the handling of the train, but when a few loaded 100,000-pound cars have to be run in the same train as 60,000-pound cars, the conditions are not favorable for smooth handling of the train. If the 100,000-pound cars are placed next to the engine, which seems to be the preferred practice of the trainmen, a burst air hose or broken coupling behind the heavy cars will invariably cause the train to separate sufficiently to come together with more or less destruction, unless there are a number of non-air brake cars at the rear end, enough to overcome the braking power and cause the rear section to maintain the same speed as the front section of the train, so that the gap will be closed up as soon as steam is shut off on the engine. On the other hand, if the 100,000-pound cars are placed behind the lighter air brake cars, the former will, on account of their greater inertia, jerk the engine back when starting, or when the slack runs out, perhaps with sufficient violence to break the train in two.

There is no real need of increasing the capacity of box and stock cars above the 60,000-pound mark, and, these cars being principally used for high class freight, which the present policy is to move on a faster schedule than required by the coal and ore traffic, the natural tendency is to separate the heavy gondolas from the rest of the freight car equipment. As long as these conditions prevail, it seems, therefore, unnecessary to make special provisions for handling 100,000-pound gondolas and 60,000-pound box cars together in the same train. If these gondolas have to return empty, they are on the same level as other empty cars as far as braking power is concerned, so that that phase of the question need not be considered.

Your suggestion, that proper application and suitable care of the present braking arrangement would meet the conditions of service, covers the subject as far as the requirements go of the high capacity cars under the conditions above stated. In order to keep up the efficiency of the brakes on these cars the inspectors must be made to give special attention to them, particularly to the adjustment of piston travel on loaded cars. Slack adjusters do certainly a great deal to keep up the braking power to the intended percentage, but it must be borne in mind, that on cars with the brakes suspended from the body, or with trucks of the Schoen type, on which the point of suspension is not constant with relation to the wheel, the slack adjuster must be of the kind that also pays out slack, so that when it has adjusted itself for a loaded car, it will not give too short piston travel and consequently too high braking power when the car is empty.

EDW. GRAFSTROM.

P. C. C. & St. L. Ry.

Columbus, Ohio.

Feb. 7, 1899.

Editor "American Engineer":

I read with interest your article on "Air Brakes for Cars of Large Capacity," and believe you are not far wrong when you say that trucks and cars have often been so designed as to render it impracticable, if not almost impossible, to put on a brake that will remain efficient after the car has run for any length of time in the usual service to which a freight car is subjected. A very much more serviceable brake can frequently be had if the beams are hung outside of the wheels. Beams thus hung have the advantage of greater clearance from the track and consequent decrease in liability of being torn off; considerably greater ease of inspection; shoes are more readily applied; and, in my opinion, based on observation, in cases of derailment the truck is less likely to turn out from beneath the car.

Those who favor inside hung brakes argue the brake shoe remains always the same height on the wheel, which is true only when the beams have no spring suspension, without which (as all who have observed know) even the rivets will loosen from constant jar, and the life of the beam and its hangings will be considerably shortened.

The idea of braking all freight cars with one length of levers when the cars vary in light weight from 20,000-pound flat cars to 45,000-pound refrigerators, is gradually going out of practice. The only reason such practice ever had for existence was that the levers of all freight equipment were thus of one size and that no car repairer could make a mistake. But such a repair man, of whom the attempt is made to steer clear, is not to be thus easily circumvented, he now shuffles up to the cylinder and truck levers and guesses which is which.

I like what you say regarding the benefit to be derived from the use of the slack adjuster. It is evident that the greater the braking power on the car the greater the wear of the brake-shoes, and consequently the more frequently must the slack be adjusted. Instead of its being a fortunate thing that there is but one prominently known slack adjuster, I believe it has worked to the disadvantage of both the manufacturer thereof and the railroads. Had the competition been greater, the already moderate price might not have been affected, but I believe there would be more adjusters in use today. I do not see where \$5, or less than 1 per cent. of the cost of the car, can be placed to better advantage than in the application of an efficient safety device, such as this certainly is. It must seem to be a trifle peculiar that with a numerical ratio of 30 or 40 box cars to one passenger car, that more slack adjusters—ten times over—should be in use on passenger than on freight cars, especially inasmuch as the former are placed on repair tracks for cleaning and proper inspection and testing of brakes on an average of once every 24 hours. Such inspection cannot be given freight cars.

Inasmuch as you mention the necessity for greater attention being paid to systematic cleaning and oiling of cylinders and triple valves, the writer would like to submit the form of record used by himself for the past three years, by which defective work can be traced to its proper source and the exact amount of such work be ascertained at a glance. [These are clearly described, and are not reproduced.—Editor.] You will note that each page of the record book has 50 numbers, one side of the leaf having the even numbers 00 to 98, while the opposite side has the odd numbers, 01 to 99. The class of cars can be stamped at the top of the page if desired. As all pages are printed alike, the top of each page is headed by writing the figures above the tens space, then all the clerk has to do is to enter the weekly reports (made on blank form herewith shown) by stamping with a rubber stamp or writing in the proper year column a letter corresponding to the telegraph call of the point where the work was done and a figure indicating the month. The last column in the weekly report serves as a check on the record for previous work. Often work recently done at some point has to be done over again very soon at other places, it is an indication of carelessness or negligence, and in no other way than by some such record as this does the writer see how it is to be known that these men on a large railroad system are doing their work well. They cannot be constantly watched, and ample opportunity is had for slighting this work.

A monthly report shows the amount of work done at each point, the number of foreign cars attended to, and the total amount of work done, giving the percentage to the total equipment of air braked cars. Since we have had this record we have more nearly accomplished the desired end—attention to the freight cars once a year—than we did before.

E. W. PRATT.

General Air Brake Inspector, C. & N. W. Ry.

Chicago, Ill., Feb. 10, 1899.

Editor American Engineer:

I have carefully gone over the editorial in your February issue referring to air brakes on cars of large capacity, and fully coincide with some of your views on the subject, but my opinion is that you did not go far enough, as this is an almost inexhaustible subject. We are practicing many ridiculous features to-day in connection with air brakes on both freight and passenger cars, and some, which it occurs to me, we have very little excuse for. Our brakes are entirely too heavy for the amount of work they have to do, and some effort must be made in the near future to reduce this weight. One of the greatest features for ridicule in our freight car brakes is that we take a car weighing 30,000 pounds and load it with 110,000 pounds of weight, and yet have the same braking power with the 140,000 pound load that we had with the 30,000-pound load. Surely there is room for improvement in this.

J. E. SIMONS,
Pittsburgh & Lake Erie R. R. Asst. Master Car Builder.
McKee's Rocks, Pa., February 21, 1899.

DISCIPLINE AND EDUCATION OF RAILWAY EMPLOYEES.

The able article by Mr. G. R. Brown on the subject of "Discipline and Education of Railway Employees," printed on page 35 of our February issue, has brought a flood of letters addressed to the "American Engineer" by progressive officers high in authority on the railways of the United States, showing how deeply railroad managements are interested and how keenly they are following up this most important subject. We deem it advisable to reprint a few of them and regret that we are not at liberty to publish the names of the writers in every case.

Chicago, Rock Island & Pacific Ry.

Chicago, February 13, 1899.

I read Mr. Brown's article with care and was very much interested in it. We have had his system in effect on the Rock Island Road for about two years now, and while I cannot say it has done all that Mr. Brown claims for it, I do think it has been of very great advantage to our company in many ways, and we have no desire to return to the old method of disciplining our men by suspension. Briefly, I think the effect of the system is to improve the personnel of the men in our operating and mechanical departments; this, first, by weeding out the poor and inefficient men, and, second, by stimulating those remaining in our employ to give the company the very best service they are capable of.

W. H. TRUESDALE,
First Vice-President and General Manager.

Boston & Maine Railroad.

Boston, February 3, 1899.

My attention has been called to the article in your issue of February, entitled "The Discipline and Education of Railway Employees," which I take pleasure in carefully reading.

LUCIUS TUTTLE,
President.

Flint & Pere Marquette R. R.

Saginaw, February 4, 1899.

The Brown System of Discipline has been in use on the Flint & Pere Marquette for some time past, and is very satisfactory. The matter has been so ably covered by Mr. Brown that any comments from me seem unnecessary. I consider Mr. Brown's article in your paper a very good one.

W. D. TRUMP,
General Superintendent.

Minneapolis, St. Paul & Ste. Marie Ry.

Minneapolis, February 9, 1899.

My attention was attracted to the article written by Mr. G. R. Brown on the "Discipline and Education of Railway Employees," under the Brown System of Discipline, in your February number. As you are probably aware, this company is using the Brown System and we find it in every way superior to the former way of handling men, and I heartily concur with Mr. Brown in the sentiments expressed therein.

E. PENNINGTON,
General Manager.

Long Island Railroad.

Long Island City, February 4, 1899.

I have followed closely the advancement and growth of what is known as the "Brown System of Discipline," and know of the favorable results obtained where the system is being followed. I take pleasure in saying that our own experience has been very successful and gratifying.

W. H. BALDWIN, JR.,
President.

Chicago, Rock Island & Pacific Ry.

Chicago, February 13, 1899.

I have read with much interest the article by Mr. G. R. Brown on "The Discipline and Education of Railway Employees," printed in your February issue. I consider this a very able article, and I coincide fully with Mr. Brown in everything which he has said, after having had an experience of nearly two and one-half years under the operation of the Brown System of Discipline. Our employees take kindly to it, and we believe we have improved our service very materially, which means in the end a large reduction in the cost of operating the road. We believe our employees to-day would, to a man, vote against going back to the old system of discipline by suspension.

W. I. ALLEN,
Assistant General Manager.

Southern Pacific Co.

San Francisco, February 7, 1899.

I have read this article by Mr. G. R. Brown, General Superintendent of the Fall Brook Railway, in your February number with much interest. Our experience with the system of discipline devised by him has been most satisfactory, both to the management and to the men.

J. KRUTTSCHNITT,
Fourth Vice-President and General Manager.

Chicago & West Michigan Ry.

Detroit, Grand Rapids & Western R. R.

Grand Rapids, February 14, 1899.

My especial attention has been called to the article by Mr. G. R. Brown in the February issue of your paper, for which I am grateful.

CHAS. M. HEALD,
President.

The Wabash Railroad.

St. Louis, February 4, 1899.

I find a very valuable article by Mr. Brown in your February number. While I have read a great many of Mr. Brown's articles, I take great pleasure in reading the one in your paper.

J. RAMSEY, JR.,
Vice-President and General Manager.

Plant System.

Savannah, February 3, 1899.

I notice in your February issue an article by Mr. G. R. Brown, General Superintendent of the Fall Brook Railway, on the subject of discipline, and take pleasure in reading this article as I have always done similar articles written by Mr. Brown.

B. DUNHAM,
General Superintendent.

_____ Railroad.

_____, February 14, 1899.

I have been following Mr. Brown's career, in connection with the question of discipline, for several years.

I regard the record system of discipline in a sense philanthropic and elevating. It must, it seems to me, nourish the virtue of gratitude on the part of employers and employees alike; the former because of the possible satisfactory results without punishing the families of those who make mistakes, as well as the improved service which it seems to me must come from a careful, conscientious, intelligent application of the system; and the latter in recognition of the many advantages accruing from being allowed to continue to earn wages, notwithstanding their errors which made it necessary to discipline them in one way or another.

As to the matter of education, we must all on general principles agree with Mr. Brown to a certain extent, and I regard this feature as one requiring very delicate treatment. I

believe the best results are to be attained by teaching men to be honest, self-reliant, and to have proper respect for authority, coupled with such training as may be necessary to make them efficient workmen in their spheres. Men of good common sense thus equipped will render better service in the lower ranks, as a rule, than those of higher education.

I realize that I am on the unpopular side of this question; but, believing that there is always a sufficient number of the better educated class of men, desirous and qualified to become good railroad men, to fill the positions of authority, by due course of promotion, I am satisfied that the companies' interests are always safe-guarded in this respect.

Vice-President.

Cincinnati, Hamilton & Dayton Ry.

Cincinnati, February 15, 1899.

Mr. Brown's ideas regarding the disciplining and education of railway men agree with mine. Being personally acquainted with Mr. Brown, I have gone over and discussed the subject with him in detail, and have no hesitancy in saying that his views and ideas are sound, and in accord with my own.

R. B. TURNER,
General Superintendent.

Columbus, Sandusky & Hocking R. R.

Columbus, February 7, 1899.

I came here last October and found nothing that corresponds to the Brown system of discipline. I am glad to see Mr. Brown's article on this subject. There is no doubt but that the principle underlying Mr. Brown's system is of great value and I propose to adopt in substance his method of dealing with my men.

G. H. KIMBALL,
Superintendent and Chief Engineer.

R. R.

February 9, 1899.

I have read the article by Mr. G. R. Brown, General Superintendent of the Fall Brook Railway, and originator of the Brown system of discipline, with a great deal of care. I have also studied the system introduced by him and have practiced it, as our road had adopted this system of disciplining employees. I was opposed to the system before it was inaugurated on our road, and I have had no occasion to regret the stand I took at the time.

I feel that when a man has disregarded the rules of the company, or through his carelessness or indifference, has caused loss of life and great damage to the company's property, for which the company finds it necessary or expedient to suspend him from the service for a certain period, after the suspension has been lived out the man feels that he has, in part, paid the company for the damage he has done, and he goes to work with a clear mind and with no club hanging over him and nothing to prevent him from exercising good judgment and rendering acceptable service to his company. The most ambitious men that we have on the road are the men who are more liable to commit slight offenses, for which demerit marks, under the Brown system, are assessed. They soon amount up to sixty marks, at which time we know that it is optional with the company whether or not they will dispense with his services. He is then working under a cloud; he is not in a frame of mind where he would render the service he would if his mind was clear; he has had placed upon his ambition a check, and, in short, it places our men in a degree of bondage, that is not, in my judgment, conducive to good service. I am very much opposed to the dismissal of old employees; men who are acquainted with the system, the officers and its rules, but I do believe that the company gets better results, the employees are happier and freer to act under the discipline by suspension than under the Brown system.

I do not write this article for publication, but if you desire to record me as being opposed to the Brown system, I have no objections.

Master Mechanic.

Columbus, Hocking Valley & Toledo Ry

Columbus, February 8, 1899.

I have carefully perused Mr. Brown's article, which appears in your February issue, and take pleasure in saying that I

heartily indorse all that he has said on the subject. Our experience with the Brown system of discipline is quite satisfactory. We show a decrease in the number of cases of discipline of 28 per cent. in the year just closed, as compared with the previous year, and one of 33 per cent. in the number of debit days accorded. I feel that this system of discipline is by far superior to the old, in fact results show this to be the case. We feel to-day that our service is as nearly perfect as it has ever been, so far as discipline is concerned, and we believe that it is largely due to the interest that the men take in the new system.

M. S. CONNORS,
Superintendent.

Long Island Railroad.

Long Island City, February 4, 1899.

I have read with interest Mr. Brown's article in your February issue. I know Mr. Brown personally, and have had the pleasure of spending some time on the Fall Brook Railroad. I believe thoroughly in Mr. Brown's method of handling men and know that the results obtained are most satisfactory. I have followed the growth of this system with great pleasure and gratification.

W. F. POTTER,
General Superintendent.

REQUIREMENTS FOR BOILER TUBES, UNITED STATES NAVY.

The Bureau of Steam Engineering of the United States Navy Department has recently issued a code of rules covering the requirement for material used in the construction of boilers and machinery for use in naval vessels from which the following in regard to boiler tubes is taken:

Lap-welded Mild Steel and Lap-welded Charcoal Iron.

The naval inspector will select three tubes from each lot of 100, and these will be subject to the following tests:

1. A piece 3 inches long, cut from one tube, must stand being flattened by hammering until the sides are brought parallel with the curve on the inside at the ends not greater than three times the thickness of the metal, without showing cracks or flaws, the bend at one side being in the weld.

2. A piece 1½ inches long, cut from one tube, must stand crushing in the direction of its axis, under a hammer, until shortened to ¾ inch for stay tubes and to ½ inch for ordinary tubes, without showing cracks or flaws.

3. The end of one tube, cold, must stand having a taper pin, taper 1½ inch to the foot, driven into it until the end of the piece stretches to 1½ times the original diameter, without showing cracks or flaws.

The failure to pass any one of these tests will reject the lot of 100.

Seamless and lap-welded mild steel tubes 3 inches in diameter and larger, for steam and water pipes. These must pass requirement No. 1, but requirement No. 2 is altered to the following, and No. 3 is omitted:

2. Two pieces, which have been cut from the ends of two test tubes, shall, after annealing, stand flanging cold to a 1 inch flange, when the diameter of the tube is from 3 inches to 6 inches, or to a 1½ inch flange when the diameter of the tube is greater than 6 inches.

The failure to pass these tests in a satisfactory manner will reject the lot.

INFRINGEMENT OF JANNEY COUPLERS.

Judge Adams handed down at St. Louis, Feb. 14, an opinion in the patent suit of the McConway & Torley Co. against the Shickle, Harrison & Howard Iron Co. The plaintiffs alleged that the St. Louis company infringed their patent on the Janney freight car couplers, on which the complainants claim a patent granted Feb. 21, 1882. Samples of this coupler were introduced in court when the case was argued. The defense was on three lines, unpatentability, anticipation and non-infringement. Judge Adams ruled that the complainant had a clear patent on this novelty, and that it has been infringed. The opinion stated that a decree will be entered granting a perpetual injunction against any further infringement and referring the case to Judge James A. Seddon, for an accounting of the damage sustained by the complainants from the infringement.

SAND DRYING AND ELEVATING APPARATUS.

Chicago, Burlington & Quincy Railroad.

The best arrangement for sand drying systems seems to be still an open question among those most interested in the cheap and efficient hauling of sand for locomotive uses, and we therefore present by courtesy of Mr. G. W. Rhodes, formerly Superintendent of Motive Power of the Chicago, Burlington & Quincy, engravings of what is considered to be an excellent installation at Chicago. The drying stoves, of which there are two, are shown in Fig. 1. These stoves are located between two reservoirs, which are below the floor line, and receive the sand after drying; the sand passing down through a valve in the top of the reservoir. An enlarged view of this valve is shown in section in Fig. 2, and its method of operation by cord and lever is shown in Fig. 1. The sand is elevated to a storage reservoir under which the dryers are situated, by means of com-

to a depth of four feet, thinking we could store sand as well below the ground level as above it. The upper portion of the shed is divided into sections, with doors that open inward and upward, so that a car can be run at any place alongside of the shed and unloaded. The sand drying room is a building nineteen feet square, and is fitted with two large drying stores, cone shaped, with the largest diameter down, the latter diameter being 4 feet 9 inches. As the sand dries it is screened into a reservoir holding about six cubic feet. The sifted sand falls through an eight-inch opening, which is closed by a cover cast with some lips that fit in a race, so that an eighth turn draws it down and makes an air tight joint at the top, and after closing the large opening air is admitted through a quarter-inch pipe to the top of the sand, and in less than a minute the

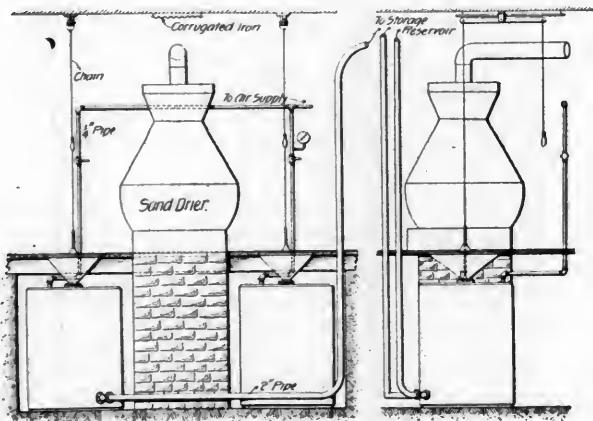


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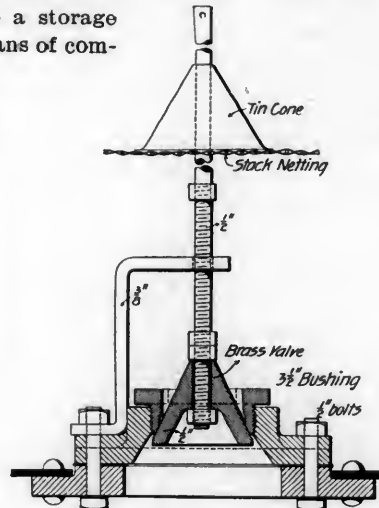


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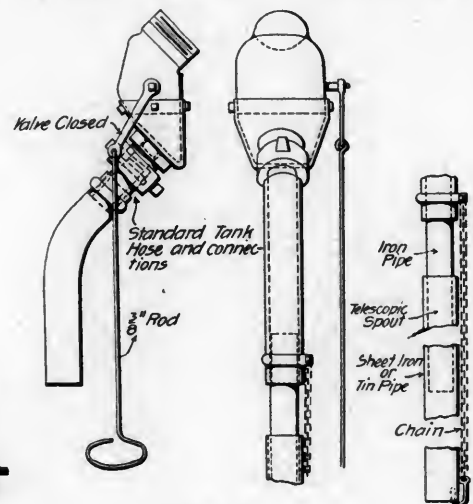


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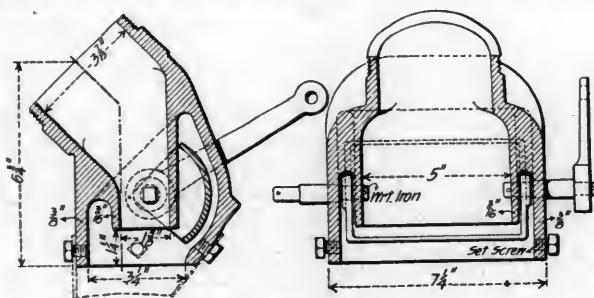


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The removal of old paint from iron surfaces has always been tedious, expensive and unsatisfactory. Hand scrapers were first used for this work, and while burners, both charcoal and gas, of the Bunsen type, have been employed, and also chemicals, the task is a difficult one that always causes delay and expense. Sand blast apparatus has been most successfully used for similar work in bridge repairing and in ship yards, and the simplicity of the appliances and rapidity of the action of the sand have led to its use in cleaning paint from tanks.

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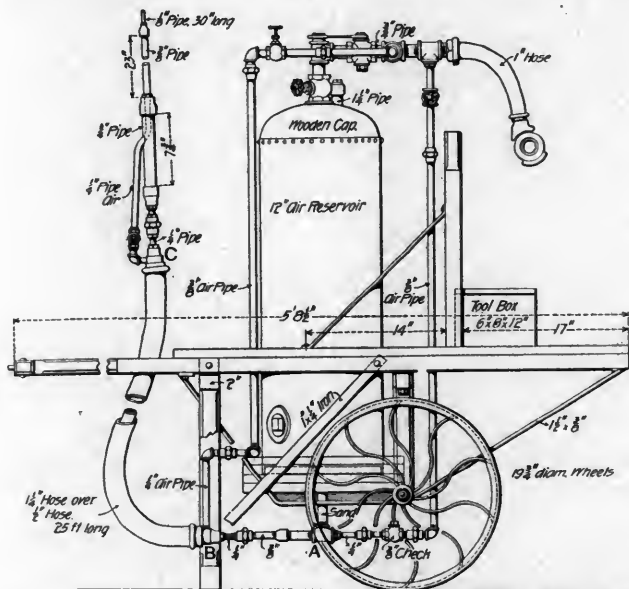
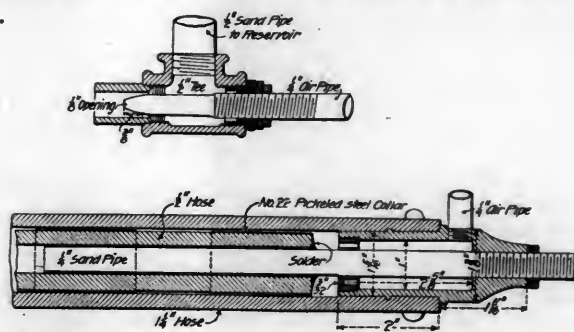


Fig. 1.—Sand Blast Machine and Nozzle.

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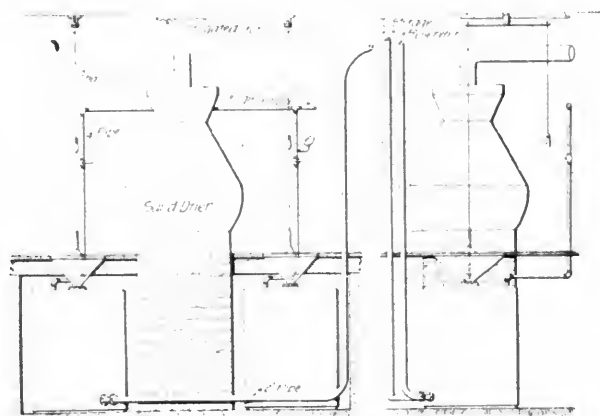


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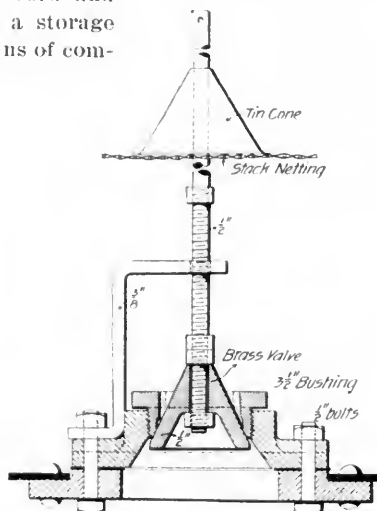


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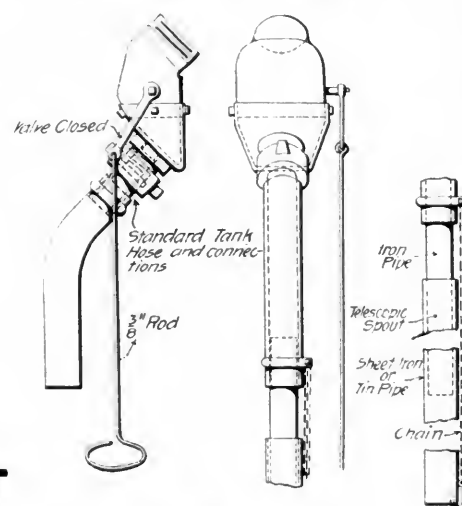


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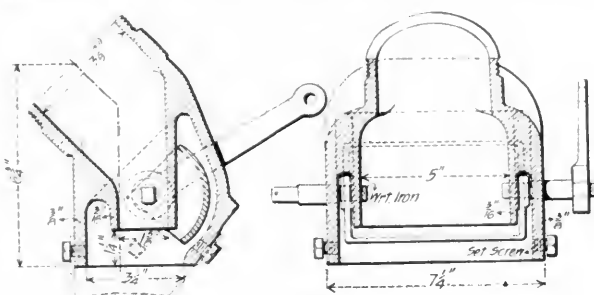


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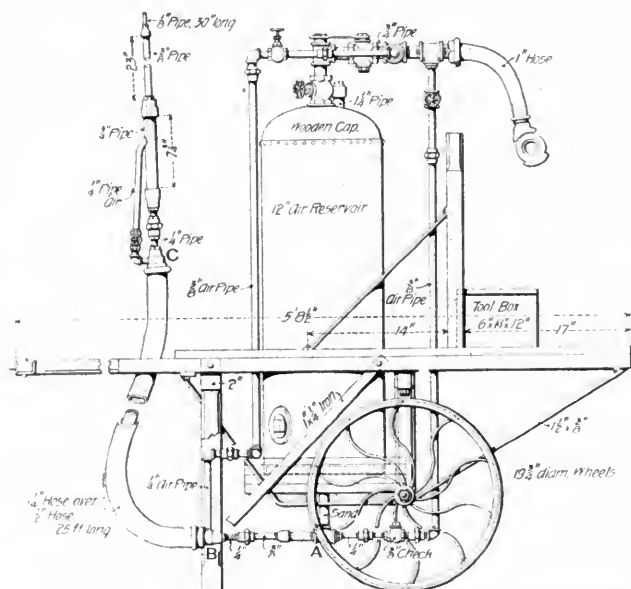
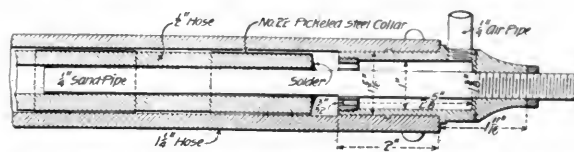
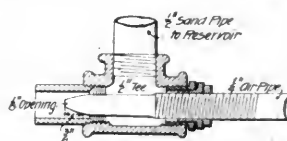


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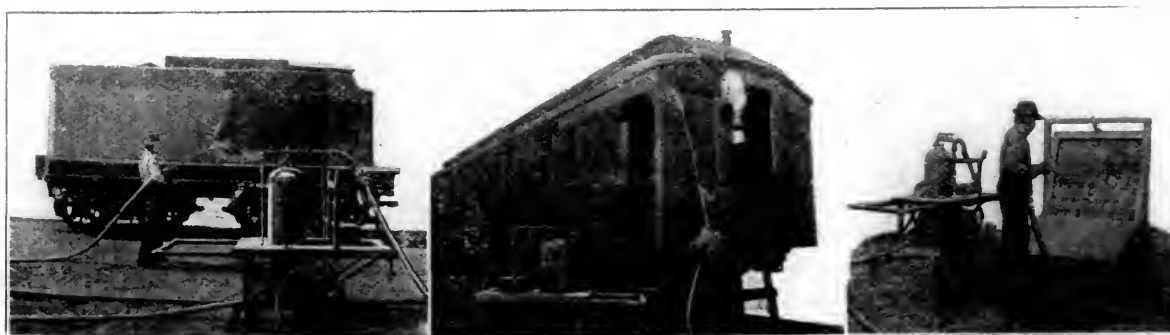


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Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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The reduction of unnecessary weight of locomotive parts is now most carefully studied, and it does not seem possible that much more may be done in this direction, but the spring rigging so far has not had a great deal of attention. It is possible that a material saving may be made in these parts, especially if coil springs with satisfactory "dampening" devices may be devised and used. It is open to question whether the heavy driving springs, spring hangers, equalizers and equalizer stands are indispensable, and the whole subject of equalization is worth investigation. With fast passenger engines the weight to be saved by coil springs would be very valuable in the boiler, and it is important to know whether the equalizers have time to act at high speeds, and whether the lack of equalization at low speeds is as important as has been believed.

The paper on friction of locomotive slide valves read by J. A. F. Aspinall before the British Institution of Civil Engineers, extracts from which we give in this issue, is one of the most valuable and interesting contributions to locomotive literature, for the very good reason that the data from which the coefficients were derived are the result of accurate and painstaking work. Additional evidence is offered disproving some old fallacies concerning the effect of port opening below the valve, on the force required to move it, and there will be less conjecture about the reactionary effect of steam under the valve than formerly. The tabulated results showing the coefficients of friction for balanced and unbalanced valves, and also the effect of lubrication, are worthy of preservation.

It has been known for some time that if the pressure within the cavity of a valve was relieved the size of the hole did not matter, but the real question concerning the balancing of valves was not reached by Mr. Aspinall, viz., the amount and distribution of the pressure exerted under the valve by the film of steam that permeates between the surface of the valve and that of the valve seat. This subject was investigated partially by Professor Robinson a number of years ago, but no data are available applying to present conditions. Our attention was recently called to the fact that on compound locomotives the amount of balance of the high-pressure valve cannot be allowed to be as large as that of the low pressure, and there is good reason to believe that a film of steam exerts an upward pressure for some distance from the edges of the valve. In the case of the high-pressure valve this effect is produced at the inside edges as well as the outside, and what we need most to know is the law governing this action. It has been suggested that the same experiment should be undertaken with flat plates, one of which is drilled to the atmosphere instead of using actual valves.

The New York Board of Railroad Commissioners have recommended legislation requiring a third man to be employed upon locomotives which are so designed, as in the case of the Wootten type, that the engineer and fireman are separated in such a way as to endanger the train in case of accident to, or the death of the engineer. The case arises as a result of several accidents which, while not involving death or injury to passengers, have possibly been narrow escapes. The question, as we see it, is whether a third man would really help the situation in the least. He would interfere with the engineer's duties, if riding on the right hand side of the cab, and on the left hand side he would not be likely to discover an accident to the engineer before the fireman would have his attention drawn to it by unusual speed or omission to give or answer signals. There is good reason to believe that the fireman, who must of necessity be on the alert for all changes in the manner of working the engine, would be the first to know of an accident to the runner, and it is difficult to see how anything better can be done than to provide good methods of communication between the two men, and it can usually be made possible for the fireman to see the runner without going forward. An extra man on a locomotive, especially if not kept constantly em-

ployed, is a source of danger, and so far as we can learn, the engineers themselves object to the proposed rule. A delegation of about thirty of them recently waited upon Governor Roosevelt, and protested against it on the ground that there would be greater danger with two engineers than with one. Human nature was human nature the world over, and it would show itself in the cab of an engine as quickly as anywhere else. The inclination to talk and visit would be given way to and one of these little visits would some day cause a horrible accident.

The desirability of giving more attention to the maintenance of brake equipment has been urged in these columns, and if further support is necessary, we have it in the record of the system of the Lake Shore and Michigan Southern Railway, presented elsewhere in this issue. The results of systematic inspection of this apparatus are convincing as to its value. We desire to remark especially on the fact that this inspection shows that cars from foreign roads that have just been given general repairs, even to painting and stenciling, at their home shops, are found with triples and cylinders in such bad condition as to need immediate overhauling and cleaning. This indicates a tendency to consider that devices which are known as automatic do not require careful attention. The Lake Shore experience also supports our position in recommending more care of present air brake equipment before advocating additional complications to take care of heavy cars.

POWERFUL LOCOMOTIVES.

Mr. Henderson's communication on fast passenger locomotives, in this issue, emphasizes some of the factors that we have been urging in the production of these engines, and his opinion of piston valves, large port openings and boiler capacity is worth pondering over. It is impossible to predict at this time to what this discussion will lead. It involves the entire locomotive, boiler, cylinders and valve motion, and a free discussion of how to make locomotives more powerful per unit of weight is worthy of the best thought and study. Greater efforts than ever before put forth in this direction are now being made by three trunk railroads of this country, which is an indication of a disposition to secure the desired result. The problem involves every type of locomotive, and from figures of improvement in fuel economy which we have seen, but cannot at this time make public, as a result of these efforts, it is made clear that railroad managements will find it to their advantage to so relieve motive power officers of the care of details which ought to be attended to by subordinates that they can devote their best attention to the locomotives and the fuel accounts. The questions which are suggested by Professor Smart and Mr. Vauclain, which were commented upon in our February issue, are understood by very few men, as inquiries among and conversations with prominent motive power officers show.

If the discussion discloses nothing else, that which has already been said concerning the port openings of valves and the provision of ample boilers is enough to keep designers busy for some time. Incidentally an opinion on the valve question may be worth mentioning. It is desirable to balance valves on account of relieving the friction and lost work of operation, but it is probably much more important to prevent the valves from lagging in their movements, due to the resistance of the valves on their seats, which causes the connections to spring and yield, with the result that the intended port openings are not obtained. It does not seem to be enough that steam ports be enlarged, unless the balancing of the valves is also improved. The piston valve is looked upon to obviate these difficulties, but even with this type the lagging of the valves is not always overcome, unless the packing rings are made in such a way as to avoid excessive friction against the casing. We shall probably print some observations on this question soon.

There is no indication of just what type the locomotive of the future is to be, but we look for large boilers, free steam pas-

sages, large port openings, balanced valves which will give the intended openings and compounding as important factors. It will not be surprising if four cylinders, separate steam and exhaust passages and separate valves, and even crank axles, are involved. If the advantages to be gained by their use are large enough, all of these will be accepted. Some remarks on the success of four-cylinder compounds in France, which we shall print in a future issue, are of interest in this connection.

THE M. C. B. COUPLER.

At the invitation of Mr. A. E. Welby, General Superintendent of the Rio Grande Western, to Mr. John Hickey, General Master Mechanic of the same road, to express himself with respect to the efficiency of the M. C. B. couplers, the latter gentleman took occasion to criticize the weaknesses of that form of coupler in his terse and emphatic style. There were few defective features of the coupler to escape notice. The expense of maintenance and application, as well as the uncertainty of security and the disappointment in experience with it, were referred to, and the lack of uniformity in the contour lines of the several makers, and also the wear on the locking devices received attention.

Several years have passed since this form of coupler was adopted by the M. C. B. Association and the weakness now so well known existed in the first of them, which indicates a slow if any movement toward improvement. The fact that there is a standard contour for the knuckle does not seem to be recognized by some makers, notwithstanding that there is room for improvement badly needed in the contact faces, which are a reproach as they stand. We are not of those who decry the M. C. B. coupler, for it is a great stride in advance of the link and pin, but it is far from perfect, and since it has become the standard of the railroads, there seems to be but one rational thing to be done with it—make it as near right as possible. Mr. Hickey's letter should have just that effect, or at least cause renewed efforts in that direction.

Such action will be forced on railroads as a measure of self-protection and not by legislation, through the necessity for something like uniformity in knuckles, and that simply means a standard. This was well shown by Mr. P. H. Peck in his paper on "The Adoption of a Standard Knuckle" before the Western Railway Club, in October, 1898. Out of a total of 77 draw bars nine of the bars had two and two bars had three knuckles each, and in only two of these bars would the knuckles interchange with each other. The effect of this condition of things on the finances of a railroad company is given by citing the requirements of one case for maintenance. There must be in way cars or at interchange points one of each kind of knuckle, averaging 48 pounds, or 4,464 pounds, which at 3½ cents would cost \$156.24. To furnish one knuckle of each of the above kinds at sixteen different points and on twenty way cars puts the cost up to \$5,624.64. This is a large price to pay for a chaotic and discreditable state of things.

Changing the point of view from that of the pecuniary advantages to be derived by an improved knuckle to the broader one of safety to life and limb, we find that, while there is a most gratifying reduction in the loss of life and mutilation of trainmen since the introduction of the automatic coupler, the murderous work still goes on. In the annual report of the Interstate Commerce Commission the compilation of the casualties to employees for the year ended June 30, 1897, made by the statistician of the Commission, is referred to by the latter as follows: "Since the enactment of the law, in 1893, there has been a decreasing number of casualties. There were 1,034 fewer employees killed and 4,062 fewer injured during the year ended Jan. 30, 1897, than during the year ended Jan. 30, 1893. In the Spanish-American war 298 men were killed, 1,645 were wounded. In 1897 there were 1,693 men killed and 27,667 injured from all causes in railway service. In coupling and uncoupling cars alone 219 fewer men were killed and 4,994 fewer men were injured in 1897 than in 1893. The number of such

employees killed has been reduced one-half, and the number of injured also practically reduced one-half. The reduction in the number of accidents from all causes largely exceeded in a single year the entire casualties during the late war."

The Commission has cause to congratulate itself on the fact that it has been instrumental in causing the removal of one cause of loss of life among trainmen, but there is reason to believe, from their own showing, that the work is not yet complete. Observation on the road and in the yard would convince the most inexperienced that many automatic couplers reverse their functions and are automatic only in uncoupling, which is certainly not the intent of their sponsors. There is no doubt that the greater portion of the casualties in coupling are due to the failure to couple and uncouple, and thus make it necessary for trainmen to go between the cars or hang to the hand holds, and thus risk their lives to perform manually what the coupler is supposed to do automatically.

The Western Railway Club has taken up a difficult but promising work by appointing a committee to investigate the coupler question thoroughly, for the purpose of making recommendations with a view of removing some of the greatest of the present difficulties, and information is now being gathered. The first thing to turn up is the great number of break-in-tuos of trains, for most of which the couplers are probably responsible. One road of 2,500 miles has an average of 18 of these per day. The trouble has many causes, and the first step toward improvement is to obtain accurate and intelligent records of how the breaks occur. Comparatively few roads keep these records, and the committee urges the importance of the information. The length of the guard arm is another branch of the subject that needs attention, and this committee is trying to point out other directions in which a general improvement may be made both in form and in character of material to be used. The best recommendations they can make will be a series of specifications and tests not only of the material, but the form and methods of locking the knuckles positively. This will be very difficult to arrange, and yet the most discouraging element in the whole situation is the tendency for railroads to take the penny-wise view. Mr. John Mackenzie said before one of the railroad clubs recently that if a railroad management could buy a coupler for 50 cents less than the cost of other couplers, that is the one they want without regard to the lines or material employed. This attitude has had much to do with the present chaotic condition, and if continued, it will defeat every effort toward improvement. Even this, however, may be overcome by specifications and tests that are so rigid as to weed out inferiority.

AUTOMATIC BRAKE SLACK ADJUSTMENT.

The niceties of airbrake operation are observed by the railroad man as one of the first things to attract his attention, and the traveling public is also becoming so well informed on the subject of what constitutes good use of brakes that one may hear the character of stops discussed on any passenger train, by men who do not know the first principles on which the brake does its work, but are well informed as to what a good stop is. The necessity for smooth operation on freight trains is not so apparent from a physical point of view, but there are financial considerations that demand it in either case, and an adjustment of the parts to overcome wear is naturally the first thing to suggest itself to keep the brake up to its best efficiency, that is, to reduce wheel sliding by uniform distribution of braking power. This is best accomplished by means of an automatic device, which, it is obvious, is preferable to hand adjustment because of the accuracy of its results, and for the reason that it does its work best while the train is in motion. On long runs, where the wear of brake shoes make slack adjustment an absolute necessity, the work cannot be done satisfactorily by hand for want of time, as has been demonstrated too many times. A

peculiarity of an adjuster that really adjusts is that it will wear out more brake shoes than one unable by functional weakness to perform its duties.

This was seen on the New York, New Haven and Hartford, when it was found necessary to reshoe an entire train each day, whereas, prior to the application of the adjuster, the train was reshod once a week. A three months' record of the same adjuster, but on another road, gave the flattering report of no flat wheels, but the opposite trains on the same run, which were not equipped with the adjuster, had forty-two flat spots reported against them in the same time. Here, evidently, the adjuster was making each car and each wheel do its full share of braking. On the transcontinental lines all the condition for a fair and impartial test of the merits of a brake slack adjuster are found, and where so tested the fittest is the only one to survive. It is the practice on the Great Northern to properly adjust the piston travel on all cars before leaving St. Paul. In making the 1,700 miles between St. Paul and Seattle the piston travel increases, in some cases, two inches. With the slack adjuster there is no adjustment needed on arrival at Seattle, and the trains return to St. Paul with the same piston travel they had on leaving that terminal. This very fine performance, as we happen to know, is an every day occurrence on that road and has been going on for several years. Fairness prompts us to say that the device we refer to is the McKee brake adjuster.

Opinions on the general subject of brake adjusters are expressed elsewhere in this issue in connection with the subject of airbrakes as applied to heavy cars. We do not believe that they are less necessary on ordinary cars, and if in certain cases they have failed to give satisfactory results it will probably be found that the relatively small amount of attention required by all such devices has not been given.

NOTES.

A wrecking train under way in seven minutes from the sounding of the alarm is the record of the Wabash at Decatur, Ill., January 25, 1899. Our informant states this was a real record and made in the course of ordinary work, the occasion being impossible for the officers or men to foresee.

Wireless telegraphy is to be tried by Signor Marconi at the South Foreland Lighthouse and on board the South Goodwin lightship, says "Engineering." If the experiment is successful the system will be adopted as a means of communication between the South Foreland Lighthouse and the South Sands Head lightship, a distance of about 3 miles.

An arrangement of separate exhaust valves of the piston type has been designed by Mr. J. A. F. Aspinall of the Lancashire & Yorkshire Railway, England. It is referred to by "The Engineer" as very satisfactory in reducing the back pressure but we should expect to find its greatest advantage to be in separate exhaust ports whereby the use of the present steam passages alternately for live and exhaust steam may be avoided.

A new speed record has been established for cruisers by the newly completed Japanese cruiser "Chitose," built by the Union Iron Works and given her official trial February 12. Mr. Irving M. Scott is quoted as saying that the average speed for 2 hours 45 minutes was 22.87 knots, and this without an accident of any description. The highest and lowest speeds were 23.76 and 22.3 knots, respectively. The "Chitose" is a protected cruiser of 4,760 tons, 402 feet 2 inches in length, and drawing 17½ feet of water. She has triple expansion engines, which are capable of developing 15,500 horse-power. Her armament will consist of two 8-inch and ten 4-inch rapid-fire guns, twelve 12-pounders, six 2½-pounders and five torpedo tubes.

Electric traction for the Manhattan Elevated has been promised for a long time, but it now seems to be assured, because of the issue of \$18,000,000 in bonds, just authorized by the directors. The president, Mr. Gould, according to a published statement, has investigated the cost of electricity on the prominent lines using it, and he believes that the change will effect a reduction of 2½ cents per car mile in the expense of operation. On the present schedule this will amount to more than \$1,000,000 per annum.

London city refuse used as fuel for electric lighting has been very successful at Shoreditch. The cost of disposing of the street refuse was formerly \$30,000 per year, which included the collection and dumping at sea. The cost of gas for street lighting was \$20,000 per year. The new electric plant cost \$60,000, and the cost for the first year was \$19,070 for labor, supplies, insurance, etc. The interest, rent, depreciation, etc., cost \$10,205, making a total of \$29,275. The gross receipts for the sale of power and light were \$43,205, giving a net profit of \$15,930.

Compound locomotives are making good records on the Chicago, Milwaukee & St. Paul Railway, where figures showing the relative coal consumption of simple and compound engines have been carefully kept for a number of years. A number of engines that are exactly alike, except as to the cylinders, gave an average advantage of 14 per cent. in fuel per 100 tons one mile, on the West La Crosse division, and of 16 per cent. on the East La Crosse division, the record covering an entire year.

The death of a locomotive engineer while running his train is reported to have occurred on the Lehigh Valley February 11. The case is somewhat similar to one on the Erie some months ago, when the runner is supposed to have met death by striking his head against an obstruction, and the accident was not discovered by the fireman until the speed of the train increased to an unusual extent. The engines are of the type in which the cab is over the boiler and the men are separated by a considerable distance.

A pleasing and profitable co-operation between the people and the railroads of Massachusetts is made evident in the 1893 annual report of the railroad commissioners of that State. There were 36 independent companies operating railroads in that State in 1872, and the number has now been reduced to 11. The report says: "The process of consolidation has been accompanied by the voluntary reduction, during the period named, of the average passenger fare from 2.43 to 1.78 cents per mile, and of the average freight rate from 2.81 to 1.22 cents per ton mile, and there has been, moreover, in the meantime, a marked improvement in the quality of the railroad service rendered."

A speed of 35.2 knots per hour is reported to have been made on a measured course of 18½ miles by the new torpedo boat destroyers built by Schichau, of Elbing, for the Imperial Chinese Navy. "Engineering" records the results, and states that a speed of 33.6 knots was made with 67 tons of coal on board, the full bunker capacity. The air pressure was from 1.58 to 1.77 inches of water, and the stokers are said to have had a comparatively easy time. The boats are 193½ feet long, 21 feet beam and of 280 tons displacement. The contract speed was 32 knots and the horse-power of the engines 6,000.

The success of the Boston subway is of special interest in connection with the proposition to construct an underground line in New York. It is often said that American people like to travel above ground too well to patronize a tunnel, but the experience in Boston shows that a good transportation scheme is popular, even if somewhat novel. "Engineering News" prints a comparison of traffic from Park Street, Boston, before and after the use of the subway, and shows an increase of 300 per cent. since December, 1894, whereas the normal increase in the surface traffic during that time would not have been more

than 40 or 50 per cent. During the first year of the operation of the complete subway the number of passengers taking and leaving the cars at Park Street Station is expected to be at least as great as the number of passengers entering and leaving Boston by the steam railroad trains at the North Union Station, or about 24,000,000, and also greater than the aggregate number of passengers entering the city last year by all the other steam roads which are soon to occupy the South Union Station. An idea of the character of the traffic is given by the statement that at Park Street Station it is necessary to load cars for 27 different routes from five consecutive berths on one track.

A magnificent increase in net earnings has accompanied the change from steam to electric traction on the South Side Elevated Railroad (The "Alley L") of Chicago, as shown in the report for the year ending December 31, 1898. The figures for net earnings for the last two months of the year are as follows:

November, 1897, steam.....	\$10,603
1898, electric	39,448
December, 1897, steam	14,691
1898, electric	45,355

The Sprague multiple unit system is in use, and these months of each year include the figures for the rental of the "Loop." The total trackage is 19.44 miles.

TESTS OF NICKEL STEEL.

Effect of Varying Proportions of Nickel.

Some interesting, though fragmentary, data from tests nickel steel are reported in "Engineering," the tests having been made at the Charlottenberg Testing Institution near Berlin. The chemical composition of the specimens used varied between 99.6 and 0.33 per cent. of iron, with 0.05 to 98.4 per cent. of nickel, the percentage of other ingredients, such as cobalt, copper, manganese, aluminum and sulphur being very small. The percentage of cobalt varied from 0.01 to 1.03 per cent., it increasing with the percentage of nickel. The effect on the physical properties of varying proportions of nickel is indicated in the table:

Per cent. of nickel.	Limit of elasticity. Lbs. per sq in.	Tensile strength. Lbs. per sq. in.	Elongation, Per cent.
0	20,630	46,472	30
8	62,496	79,520	10
16	.....	58,240	1
30	.....	14,224	2
60 to 98.5	.....	53,760 to 42,560	36 to 17

Increasing the proportion of nickel from 0 to 8 per cent. steadily increased the elastic limit and tensile strength, the greatest strength accompanying the largest amount of nickel. Increasing the nickel caused irregular results, as shown by the table. Porous fractures were obtained with 0.5 per cent. of nickel becoming close with 1 per cent. Three per cent. gave fractures of fine grain and proportion increasing above this made them coarser until needle-shaped crystals were finally obtained. An exception was found with 60 per cent. of nickel which gave normal strength and fine grain. The compression tests gave results similar to those in tension. Experiments in rolling showed that the process could not be used with more than 4 per cent. nickel and fractures occurred with higher percentages.

PURDUE UNIVERSITY.

Mr. Robert S. Miller has been appointed Assistant Professor in charge of the Department of Machine Design, and Mr. L. V. Ludy has been made Assistant in the Engineering Laboratory, assuming the work which has hitherto been carried on by Mr. Miller.

Mr. Miller is a graduate of the School of Electrical Engineering, class of '95, and received the degree of Mechanical Engineer from the same institution in '97. Since graduating he has been assistant in the Engineering Laboratory, and later instructor in mechanical engineering. In addition to his routine work at Purdue he had a leading part in the exhaustive series of tests made two years ago at Purdue upon the balanced compound locomotive, and last year was in immediate charge of the fuel tests made at the University for the Big Four Road, and still more recently assisted in the duty test of the 20,000,000 gallon Snow pumping engine at Indianapolis, the results of which have attracted general attention.

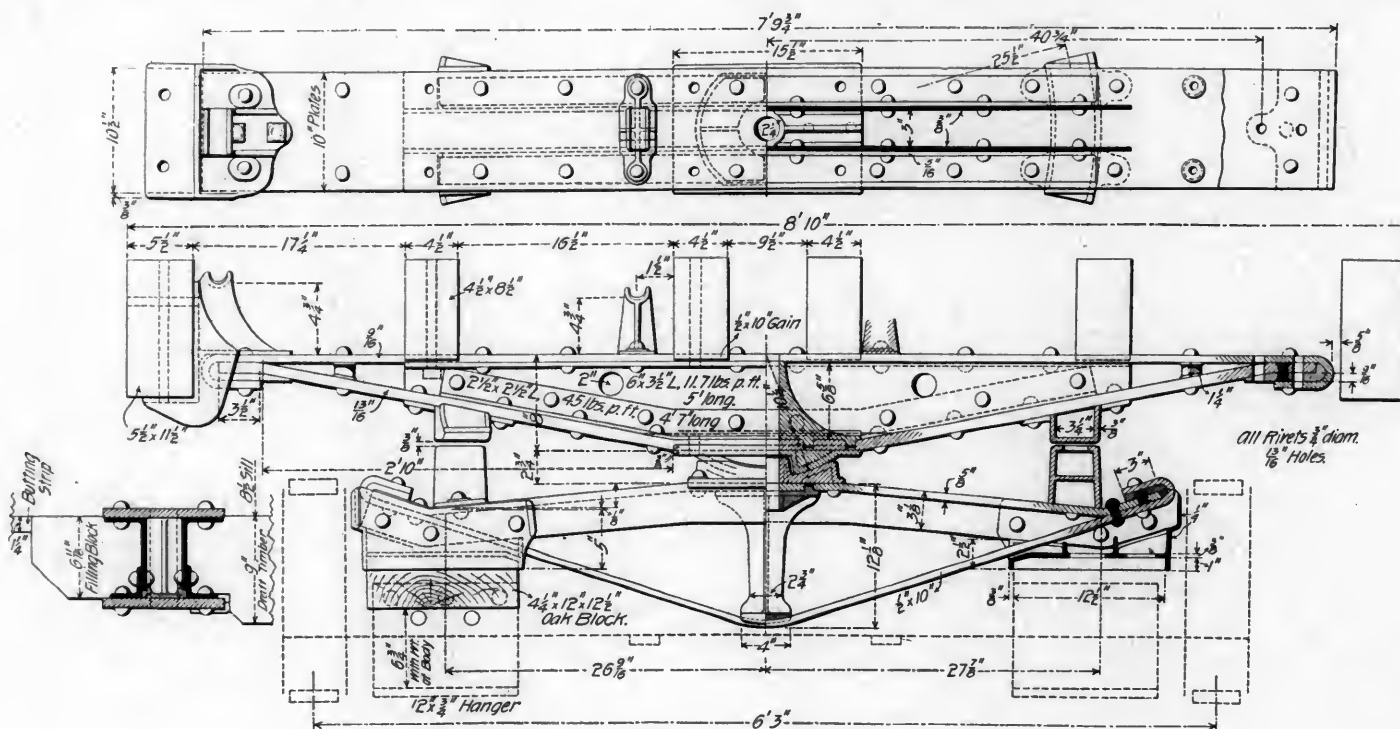
SIMPLEX BODY AND TRUCK BOLSTERS.

Southern Railway.

The arrangement of simplex bolsters shown in our engraving is an adaptation to the requirements of the 60,000-lb. capacity gondola cars of the Southern Railway. They are designed to supplant 6 by 16-inch oak body bolsters, with two 1¼-inch truss rods, and 12 by 12-inch oak truck bolster, having two truss rods of 1-inch body and 1¼-inch ends. A contrast could hardly have been made more striking than by the selection of these two representatives of bolster practice—the one standing for advanced mechanical construction, and the other an example of a type doomed to be soon obsolete, but where still seen it serves to emphasize the fact that old standards are kept long after their usefulness has departed, although

VALUE OF GOOD STAYBOLT IRON.

To illustrate the actual saving effected by buying the best of boiler material we quote remarks by Mr. Higgins, Superintendent of Motive Power of the Lehigh Valley, in a discussion before the New York Railroad Club as follows: "We have had some experience with staybolt iron of various qualities. Up to four years ago the road I am with bought staybolt iron, or what was called staybolt iron, at a certain price. We then commenced ordering stay-bolt iron costing three times as much per pound as what we had been using. Previous to the change we ordered on an average twelve tons of staybolt iron per month. Since the change we have ordered on an average five tons of iron per month, and the longer we continue using the more expensive iron, the less the amount ordered each month. Or, in other words, some time had to elapse before we really commenced to



Body and Truck Bolsters—Southern Railway.
The Simplex Railway Appliance Co.

the heavy capacity equipment has practically driven the wooden affairs out of commission.

A height of 8 inches is in this case allowable over the plates of the body bolster at the center, which gives an ample trussing effect in conjunction with the two ¾ by 3½ by 6-inch angles, the long sides of which are placed vertically between the two bolster plates and extend to the outside face of the intermediate sills, being cut to fit at the lower edges. These angles are riveted through their short flanges to the upper plate of the bolster, while the long sides are in turn riveted to 2½ by 2½-inch angles that are riveted to the bottom bolster plates, a construction that is very stiff, as will be seen in the separate sectional detail.

The truck bolster consists simply of a 12-inch channel compression member and a ½ by 10-inch plate tension member, and is too well known to require a description, it having appeared in our October, 1898, issue in connection with its application to the tenders of the Chesapeake & Ohio new class G-6 consolidation engines. These bolsters are made by the Simplex Railway Appliance Company, Chicago, and are making rapid strides in both locomotive and car equipment in which stiffness, lightness and durability are the prime requisites.

feel the effect of having the better iron for staybolts in the boiler. This reduction in the amount of staybolt iron ordered has occurred, notwithstanding the fact that there has been quite a large increase in the number of engines owned by the road."

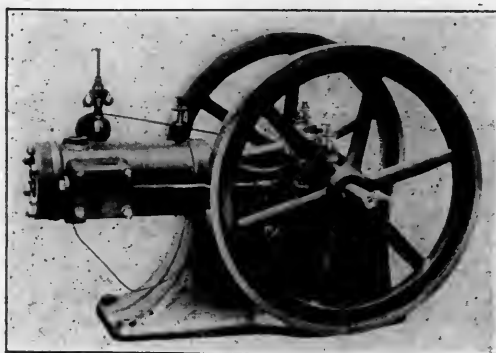
MAGNOLIA METAL COMPANY WINS PIRACY SUITS.

We learn with pleasure that the protracted law cases which have been pursued in England by the Magnolia Anti-Friction Metal Company, Limited, the London branch of the Magnolia Metal Company here, in defense of their rights to their celebrated brand, and their business, has been decided in their favor against John Sugdon, W. E. Watson, A. G. Brown, the Atlas Bronze Company, Limited, and the Atlas Metal Company, Limited, and others who were enjoined respecting patents and trademarks, and from engaging in any anti-friction metal business, with costs and damages. The text of the decision, as it appears in the English papers at hand, is very severe and sweeping. We congratulate the Magnolia Metal Company upon this result; the cases have been prosecuted with great vigor, and no doubt large expense, and it is of value to Americans registering and appealing to English laws to know that they do and will protect when properly appealed to.

THE SUMNER GAS AND GASOLINE ENGINES.

The adaptability of gas and gasoline engines to the service of railroads for pumping and raising coal received comment in our February issue, and an appreciation of the advantages to be gained by their use will undoubtedly be followed by almost universal application of these engines for such service.

The Sumner engine, made by the F. M. Watkins Co., of Cincinnati, Ohio, illustrated in the accompanying engraving, is the result of experiments and improvements covering 15 years, and it is now used in place of steam engines up to 25 horse power, the one shown being the 4 horse power size. The parts of the engine, particularly the bearing surfaces, are large, being designed with reference to long wear. Cheapness of first cost is not sought after at the expense of good, durable construction. The bearings are of phosphor bronze, and all parts are made on the interchangeable plan, which would not be possible with babitted bearings. The crank shafts and connecting rods are forged from solid steel billets and the fly wheels, which



The Sumner Gas and Gasoline Engine.

are double for all but the 2 horse power engine, are very heavy. The best grade of iron is used in the castings, the base and cylinders being of very hard iron to insure long life.

One of the features for which much is claimed by the builders is the electric igniter, which makes use of a magneto machine, employed only in the Sumner engine. These are used with the expectation that they will last as long as the engine and effect a great saving over the batteries that are generally employed for obtaining the sparks for ignition. The magneto is advocated because of avoiding the cost of renewing and replacing batteries and tube igniters. It is clear that igniting devices that may be depended upon not to fail at critical times must be appreciated, and uncertainty in this regard has undoubtedly exerted an influence in retarding the introduction of internal combustion engines. These builders guarantee the igniting devices to work satisfactorily for two years, and some are now running in good order after five years of continuous service, and show no signs of deterioration. The magneto generator is very simple. Its commutators are in the form of hardened steel rings with self adjusting brushes of softer material. The armature is incased in a brass box, which may be seen between the spokes of the fly wheel in the engraving. The armature is geared to the main shaft, and current for starting the engine is generated by turning the fly wheel slowly by hand for the first ignition. The spark is produced in a special ignition cavity away from oil and where the gas is richest, to insure regular and economical ignition. The spark is produced by bringing the electrodes together slowly and suddenly separating them in such a way as to avoid wearing and battering the electrodes. The condition of the contact points may be observed at any time while the engine is running, and they may also be cleaned without stopping or interfering with the operation of the engine. The makers claim simplicity, reliability and durability for the igniter, and also that it lights every charge, does not deteriorate or burn out and is permanent.

When using gasoline—ordinary stove gasoline is used—the supply is pumped from a safety tank placed under ground and

outside of the building. It is so arranged that any surplus raised by the pump and not needed in the cylinder returns automatically to the tank. The supply pump has no stuffing box, and as the valves are always sealed by gasoline, it does not require priming. The gasoline is supplied in the form of an atomized spray, which is mixed thoroughly with the proper amount of air so that the ignition is complete at the dead point. The gas mixer balances the gas pressure in such a way as to dispense with check valves. The gas and air valves are combined in one, which is applicable to natural or artificial gas, and the builders state that this mixer makes it possible to start the engine with certainty on the second turn of the fly wheel. The governor regulates the pressure in the cylinder in proportion to the work to be done, and permits of obtaining an explosion for each alternate revolution. The makers say that it gives a regulation within 1 per cent., permitting of running electric light generators direct from the driving pulley.

The ease of starting is a special claim for the Sumner engine, and on large sizes automatic starting devices are used whereby the time for starting is reduced to 30 seconds.

TONNAGE RATING ON THE CANADIAN PACIFIC.

An accurate rating by tons of the hauling capacity of locomotives has for some time been understood as one of the most vital elements in the transportation problem, but it is only very recently that systematic effort has been made to reap the benefits of minimum loading. The apathy existing in some quarters is perhaps explainable by the fact that undue importance has been given to the supposed magnitude of the undertaking of the establishment of a rational system to fit individual conditions. Among the later roads to adopt a plan of this kind is the Canadian Pacific, which has evolved a system of its own, embracing a rating for each locomotive on the road, and in each direction for a given district. This rating applies to 673 engines and includes twelve classifications for freight service.

The fundamental feature of this system is to give each class of engine a rating equal to a given percentage of an established standard. This percentage covers a range from 143 per cent. down to 60 per cent. The trains are embraced under the two heads of ordinary freights and fast freights, and with the ordinary freights as a base, there is a deduction made for ordinary and bad rail conditions, and also for temperature from zero to 32 degrees plus, from zero to 20 degrees minus, and for a temperature colder than 20 degrees minus. As showing the elasticity of this scheme, the Superintendents may, in special cases not provided for by the rules, authorize a special rating, and in addition to this the hauling rating of locomotives in wind or snow storms will be governed at the time according to conditions.

Tabulated values of the tonnage capacity of each class of engine simplifies the system for the use of those making up the trains, and reduces the work of assigning tonnage down to a few calculations in order to find the proper load. There has always been considerable diversity of opinion as to what should be the allowable weight for empties of all kinds. Five tons is allowed in this tonnage system for each empty freight car, in addition to the tare of the car. An exception to this is noted in case of long palace horse cars and refrigerator cars. A similar reduction is made in the capacity of an engine moving with the tender ahead, and also with double-head or pushing engines. To remove all doubt as to what allowance to make for equipment on which the tare weight is unknown, a table of estimated weights is furnished, which includes every type of car on the road, which is an evidence of care to leave no element of doubt or any chance for misconstruction. In fact, the whole system appears to be framed with the one purpose in view of having it plain enough to be understood and used. It is in operation on the Ontario and Quebec division under the supervision of General Manager Thomas Tait, with results of the most satisfactory character.

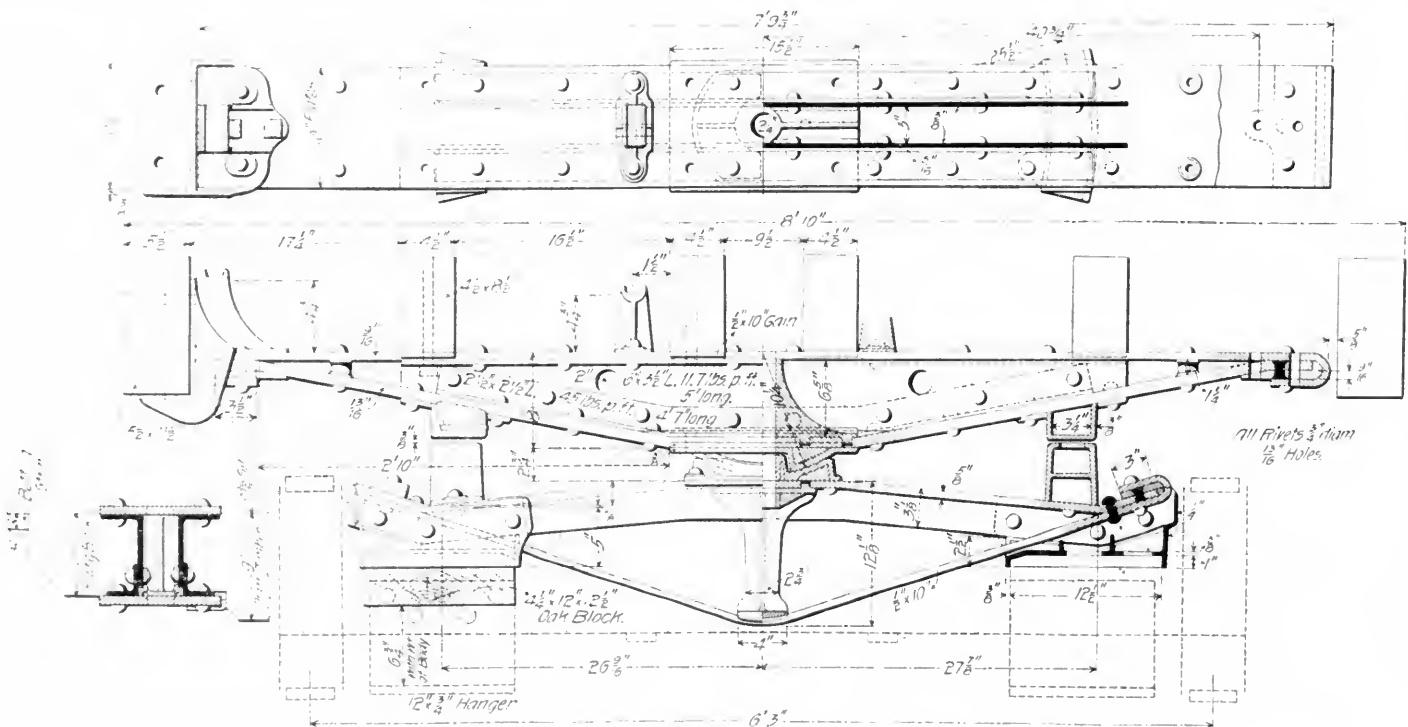
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A height of 8 inches is in this case allowable over the plates of the body bolster at the center, which gives an ample trussing effect in conjunction with the two ¾ by 3½ by 6-inch angles, the long sides of which are placed vertically between the two bolster plates and extend to the outside face of the intermediate sills, being cut to fit at the lower edges. These angles are riveted through their short flanges to the upper plate of the bolster, while the long sides are in turn riveted to 2½ by 2½-inch angles that are riveted to the bottom bolster plates, a construction that is very stiff, as will be seen in the separate sectional detail.

The truck bolster consists simply of a 12-inch channel compression member and a ½ by 10-inch plate tension member, and is too well known to require a description, it having appeared in our October, 1898, issue in connection with its application to the tenders of the Chesapeake & Ohio new class G-6 consolidation engines. These bolsters are made by the Simplex Railway Appliance Company, Chicago, and are making rapid strides in both locomotive and car equipment in which stiffness, lightness and durability are the prime requisites.

feel the effect of having the better iron for staybolts in the boiler. This reduction in the amount of staybolt iron ordered has occurred, notwithstanding the fact that there has been quite a large increase in the number of engines owned by the road."

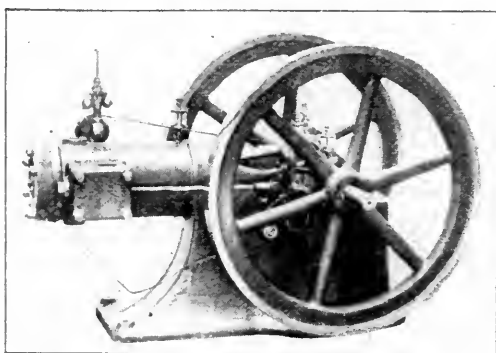
MAGNOLIA METAL COMPANY WINS PIRACY SUITS.

We learn with pleasure that the protracted law cases which have been pursued in England by the Magnolia Anti-Friction Metal Company, Limited, the London branch of the Magnolia Metal Company here, in defense of their rights to their celebrated brand, and their business, has been decided in their favor against John Sugden, W. E. Watson, A. G. Brown, the Atlas Bronze Company, Limited, and the Atlas Metal Company, Limited, and others who were enjoined respecting patents and trademarks, and from engaging in any anti-friction metal business, with costs and damages. The text of the decision, as it appears in the English papers at hand, is very severe and sweeping. We congratulate the Magnolia Metal Company upon this result; the cases have been prosecuted with great vigor, and no doubt large expense, and it is of value to Americans registering under and appealing to English laws to know that they do and will protect when properly appealed to.

THE SUMNER GAS AND GASOLINE ENGINES.

The adaptability of gas and gasoline engines to the service of railroads for pumping and raising coal received comment in our February issue, and an appreciation of the advantages to be gained by their use will undoubtedly be followed by almost universal application of these engines for such service.

The Sumner engine, made by the F. M. Watkins Co., of Cincinnati, Ohio, illustrated in the accompanying engraving, is the result of experiments and improvements covering 15 years, and it is now used in place of steam engines up to 25 horse power, the one shown being the 4 horse power size. The parts of the engine, particularly the bearing surfaces, are large, being designed with reference to long wear. Cheapness of first cost is not sought after at the expense of good, durable construction. The bearings are of phosphor bronze, and all parts are made on the interchangeable plan, which would not be possible with babitted bearings. The crank shafts and connecting rods are forged from solid steel billets and the fly wheels, which



The Sumner Gas and Gasoline Engine.

are double for all but the 2 horse power engine, are very heavy. The best grade of iron is used in the castings, the base and cylinders being of very hard iron to insure long life.

One of the features for which much is claimed by the builders is the electric igniter, which makes use of a magneto machine, employed only in the Sumner engine. These are used with the expectation that they will last as long as the engine and effect a great saving over the batteries that are generally employed for obtaining the sparks for ignition. The magneto is advocated because of avoiding the cost of renewing and replacing batteries and tube igniters. It is clear that igniting devices that may be depended upon not to fail at critical times must be appreciated, and uncertainty in this regard has undoubtedly exerted an influence in retarding the introduction of internal combustion engines. These builders guarantee the igniting devices to work satisfactorily for two years, and some are now running in good order after five years of continuous service, and show no signs of deterioration. The magneto generator is very simple. Its commutators are in the form of hardened steel rings with self adjusting brushes of softer material. The armature is incased in a brass box, which may be seen between the spokes of the fly wheel in the engraving. The armature is geared to the main shaft, and current for starting the engine is generated by turning the fly wheel slowly by hand for the first ignition. The spark is produced in a special ignition cavity away from oil and where the gas is richest, to insure regular and economical ignition. The spark is produced by bringing the electrodes together slowly and suddenly separating them in such a way as to avoid wearing and battering the electrodes. The condition of the contact points may be observed at any time while the engine is running, and they may also be cleaned without stopping or interfering with the operation of the engine. The makers claim simplicity, reliability and durability for the igniter, and also that it lights every charge, does not deteriorate or burn out and is permanent.

When using gasoline—ordinary stove gasoline is used—the supply is pumped from a safety tank placed under ground and

outside of the building. It is so arranged that any surplus raised by the pump and not needed in the cylinder returns automatically to the tank. The supply pump has no stuffing box, and as the valves are always sealed by gasoline, it does not require priming. The gasoline is supplied in the form of an atomized spray, which is mixed thoroughly with the proper amount of air so that the ignition is complete at the dead point. The gas mixer balances the gas pressure in such a way as to dispense with check valves. The gas and air valves are combined in one, which is applicable to natural or artificial gas, and the builders state that this mixer makes it possible to start the engine with certainty on the second turn of the fly wheel. The governor regulates the pressure in the cylinder in proportion to the work to be done, and permits of obtaining an explosion for each alternate revolution. The makers say that it gives a regulation within 1 per cent., permitting of running electric light generators direct from the driving pulley.

The ease of starting is a special claim for the Sumner engine, and on large sizes automatic starting devices are used whereby the time for starting is reduced to 30 seconds.

TONNAGE RATING ON THE CANADIAN PACIFIC.

An accurate rating by tons of the hauling capacity of locomotives has for some time been understood as one of the most vital elements in the transportation problem, but it is only very recently that systematic effort has been made to reap the benefits of minimum loading. The apathy existing in some quarters is perhaps explainable by the fact that undue importance has been given to the supposed magnitude of the undertaking of the establishment of a rational system to fit individual conditions. Among the later roads to adopt a plan of this kind is the Canadian Pacific, which has evolved a system of its own, embracing a rating for each locomotive on the road, and in each direction for a given district. This rating applies to 673 engines and includes twelve classifications for freight service.

The fundamental feature of this system is to give each class of engine a rating equal to a given percentage of an established standard. This percentage covers a range from 143 per cent. down to 60 per cent. The trains are embraced under the two heads of ordinary freights and fast freights, and with the ordinary freights as a base, there is a deduction made for ordinary and bad rail conditions, and also for temperature from zero to 32 degrees plus, from zero to 20 degrees minus, and for a temperature colder than 20 degrees minus. As showing the elasticity of this scheme, the Superintendents may, in special cases not provided for by the rules, authorize a special rating, and in addition to this the hauling rating of locomotives in wind or snow storms will be governed at the time according to conditions.

Tabulated values of the tonnage capacity of each class of engine simplifies the system for the use of those making up the trains, and reduces the work of assigning tonnage down to a few calculations in order to find the proper load. There has always been considerable diversity of opinion as to what should be the allowable weight for empties of all kinds. Five tons is allowed in this tonnage system for each empty freight car, in addition to the tare of the car. An exception to this is noted in case of long palace horse cars and refrigerator cars. A similar reduction is made in the capacity of an engine moving with the tender ahead, and also with double-head or pushing engines. To remove all doubt as to what allowance to make for equipment on which the tare weight is unknown, a table of estimated weights is furnished, which includes every type of car on the road, which is an evidence of care to leave no element of doubt or any chance for misconstruction. In fact, the whole system appears to be framed with the one purpose in view of having it plain enough to be understood and used. It is in operation on the Ontario and Quebec division under the supervision of General Manager Thomas Tait, with results of the most satisfactory character.

double brace at the smokebox, having a central foot common to both braces, this foot being riveted to the smokebox just above the junction of the latter with the cylinder saddle. These braces extend front and back, the former going forward to the front of frame and the latter back to the guide yoke. This construction presents an odd appearance at this time because we have gradually outgrown the idea of the necessity for front end braces in the last few years, but there is no question of the value of these braces in relieving the saddle bolts of a considerable tendency to shearing.

An example of the certain passing of the extension front is to be noted on these engines; the fronts are fitted with the improved Bell spark arrester, and are only long enough to take in the cinder hopper, while the length is sufficient to admit the headlight in front of the stack, the lampboard being flush with the door ring. The construction of the reverse shaft is with one central lifting arm for the two link hangers. It is peculiar to the Brooks Works and a good plan. A safe stowage place for the main air reservoir is seen to be between the frames at the rear of the main drivers; the reservoir is slung by two stirrups that are secured to a casting resting on the frames. The use of the Wootten firebox on the Long Island is the result of the policy of the company to reduce the smoke nuisance as far as possible, and to that end locomotives recently overhauled have been fitted with this firebox. These engines have fireboxes 7 by 10 feet, and a total heating surface of 1,952 square feet. Our engravings show the general appearance and many of the detail dimensions of the engines.

On a dry rail they will exert a draw bar effort of 35,000 pounds. They are cylindered up to their adhesive weight, or, in other words, they do not carry any superfluous load on their drivers with the expectation of some day meeting with a slippery rail. This will be seen by the coefficient of adhesion of 0.261. It is notable, by the way, that the latest designs of heavy locomotives show a tendency toward a high coefficient, it being understood that the sanding devices can take care of an occasional adverse condition of rail. A description of these engines will be found below:

General Description.

Kind of fuel to be used.....	Anthracite and soft coal
Weight on drivers.....	135,000 pounds
" " trucks.....	20,000 pounds
" total.....	155,000 pounds
" tender, loaded.....	86,000 pounds

Dimensions.

Wheel base, total, of engine.....	32 feet 9 inches
" " driving.....	14 feet 6 inches
" total, engine and tender.....	49 feet 6 inches
Length over all, engine.....	35 feet
" total, engine and tender.....	60 feet ¾ inch
Height, center of boiler above rails.....	8 feet 8 inches
of stack above rails.....	14 feet 3½ inches
Heating surface, firebox.....	1,773 square feet
" tubes.....	1,773 square feet
" total.....	1,953 square feet
Grate area.....	69 square feet

Wheels and Journals.

Drivers, diameter.....	51 inches
" material of centers.....	Cast steel
Truck wheels, diameter.....	30 inches
Journals, driving axle.....	8 by 10 inches
" truck.....	5½ by 10 inches
Main crank pin, size.....	6¼ by 6 inches

Cylinders.

Cylinders, diameter.....	21 by 28 inches
Piston rod, diameter.....	4 inches
Main rod, length center to center.....	120 inches
Steam ports, length.....	18 inches
" width.....	1½ inches
Exhaust " length.....	18 inches
" width.....	3 inches
Bridge, width.....	1½ inches

Valves.

Valves, kind.....	Richardson balanced
" greatest travel.....	6¼ inches
" outside lap.....	¾ inches
" inside.....	None
Lead in full gear.....	None

Boiler.

Boiler, type.....	Straight top
" working steam pressure.....	180 pounds
" thickness of material in barrel.....	11-16 inch
" " tube sheet.....	½ inch
" diameter of barrel.....	72 inches
Crown sheet, stayed with.....	Radial stays
Dome, diameter.....	30 inches

Firebox.

Firebox, type.....	Wootten over wheels
" length.....	120 inches

Firebox width.....	84 inches
" depth, front.....	64 inches
" " back.....	58 inches
" material.....	Steel
" thickness of sheets.....	Tube, ½ inch; sides, top and back ¾ inch
" Brick arch.....	None
" mud ring, width.....	Back, 3½ inches; sides, 3½ inches; front, 4 inches
Grates.....	Cast-iron shaking
Tubes, number.....	294
" material.....	Charcoal iron
" outside diameter.....	2 inches
" thickness.....	No. 11 B. W. G.
" length over tube sheets.....	11 feet 7.3-16 inches

Smokebox.

Smokebox, diameter, outside.....	75 inches
" length from flue sheet.....	63 inches

Other Parts.

Exhaust nozzle.....	Single
" diameter.....	5 inches; 5 3-16 inches; 5½ inches
" distance of tip above center of boiler.....	1 inch
Netting, wire or plate.....	Wire
" size of mesh or perforation.....	2½ by 2½ inches, and 2¼ by 1¼ inches
Stack, straight or taper.....	Steel taper
" least diameter.....	15½ inches
" greatest.....	18½ inches
" height above smokebox.....	30 inches

Tender.

Type.....	8-wheel, steel frame
Tank capacity for water.....	4,000 gallons
" " coal.....	8 tons
" material.....	Steel
" thickness of sheets.....	3-16 inch and ¼ inch
Type of underframe.....	Steel channel
" springs.....	Half elliptic
Diameter of wheels.....	33 inches
" and length of journals.....	4¼ by 8 inches
Distance between centers of journals.....	5 feet 4 inches
Diameter of wheel fit on axle.....	5½ inches
" center of axle.....	4¼ inches
Length of tender over bumper beams.....	23 feet 6 inches
" tank.....	20 feet
Width " ".....	8 feet 7 inches
Height " " not including collar.....	52 inches

Special Equipment.

Brakes.....	American for drivers; Westinghouse for tender and train service.
Pump.....	9½ inches
Sight feed lubricators.....	Detroit
Safety valves.....	Prince
Injectors.....	Sellers
Springs.....	French
Spark arresters.....	Bell's improved

STREET CAR BRAKES.

What would appear to be an excellent opening for the exercise of the inventive faculty is to be found in the want of a satisfactory braking system on street cars. The old crude devices used on horse cars is doing duty on electric cars, and while they were never good, they are now simply a reproach to those responsible for their use at this day, when a good brake is as much of a necessity in crowded street traffic as on a steam road. The numerous crippings and deaths resulting from the failure to provide a suitable brake have aroused the New York State Railroad Commission to action in the matter, and they have invited all those interested in power brakes to assist at a test of such brakes in New York city on the tracks of the Metropolitan Street Railway Company. The excuse for the continuance of the old hand-brake, namely, that no satisfactory power brake had ever been devised, will not satisfy the present inquiry, and we may now expect to see some improvement. Brake shoes should come in for a share of attention in this test, as they are exceedingly important in influencing the quickness of stops.

WATER IMPURITIES.

The Master Mechanics' Association Committee on "Best Method of Preventing Trouble in Boilers from Water Impurities" is seeking information on the above subject for presentation before the convention next June. The information asked for in the circular of inquiry is confined strictly to the troubles that occur from impure water; what has been done to overcome such trouble; the cost per thousand miles for purification; the cost for same mileage for boiler washing; how the cost of washing has been affected by the use of purifiers, and to what extent; the average life of flues and fireboxes, and instructions to engineers and roundhouse men in connection with the use of water-purifying methods. The committee is composed of Messrs. A. E. Manchester of the Milwaukee, J. H. Manning of the Union Pacific, S. P. Bush of the Pan Handle, Henry Bartlett of the Boston & Albany, and R. M. Galbraith of the St. Louis Southwestern, representing experience covering all parts of the country and presumably every kind of water used in the United States. It will be noted that the information desired does not have to do with the chemistry of the subject, but is purely mechanical.



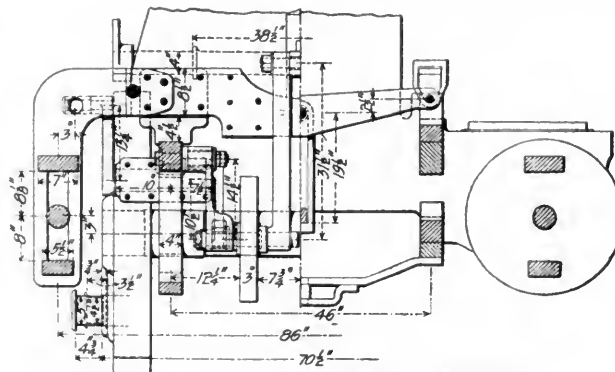
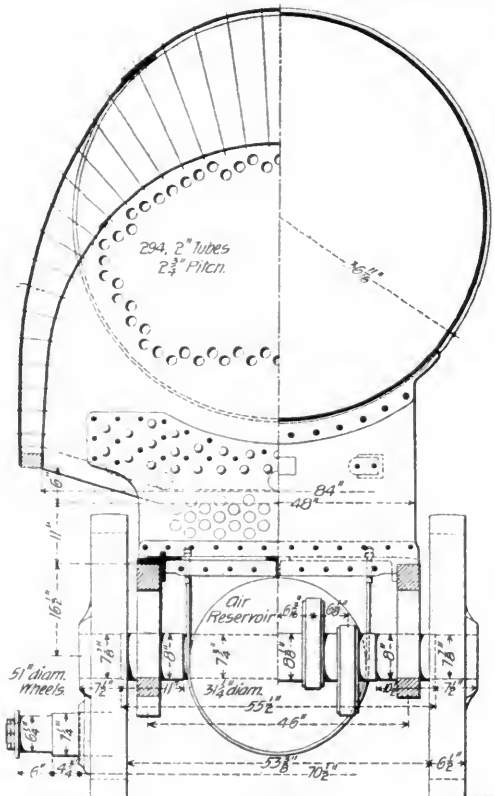
The New Consolidation Locomotive, Long Island Railroad.

CONSOLIDATION FREIGHT LOCOMOTIVE.

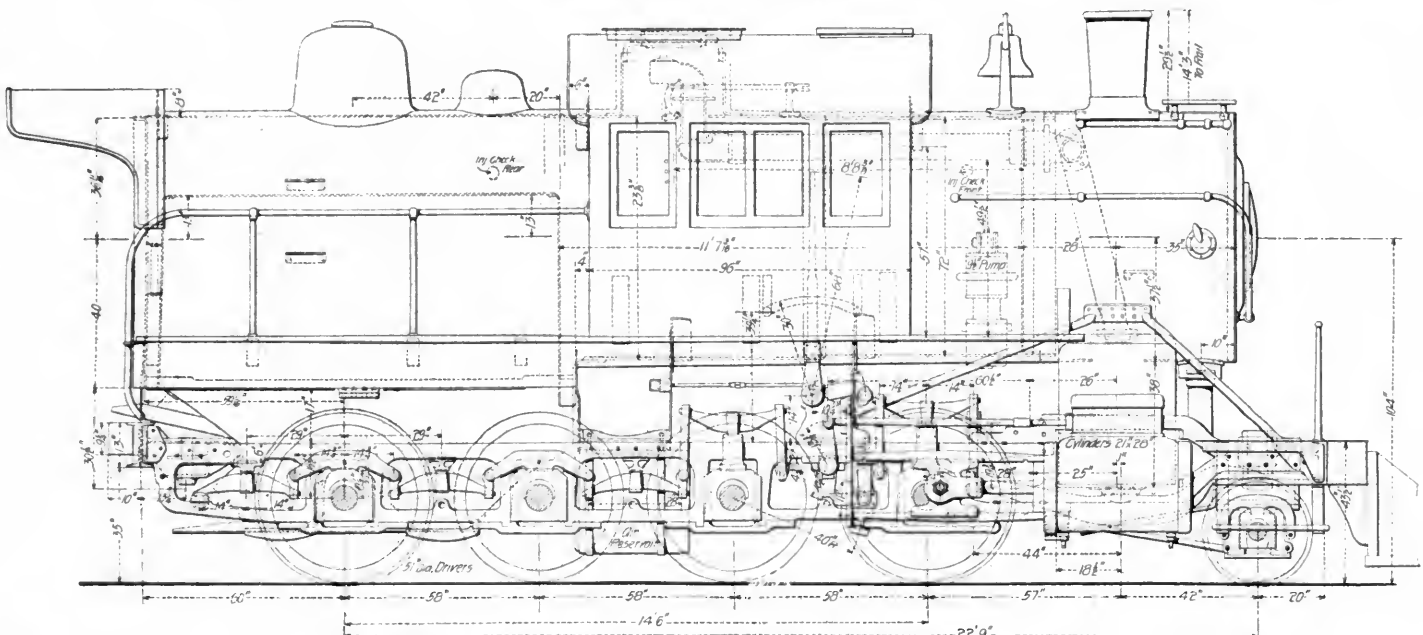
Long Island Railroad.

The engravings of the 21 by 28-inch consolidation engine represent a lot recently built for the Long Island Railroad by the Brooks Locomotive Works. Locomotives of this size and type are new on the Long Island Railroad, and may be accounted for on the ground that the management is preparing to move a larger tonnage than heretofore. These engines have the Wooten firebox and are thus designed to burn either anthracite or soft coal. The boiler, owing to the style of firebox, stands high in the air, the center being 104 inches above the rail.

In order to secure proper longitudinal stability, there is a



Sections of Locomotive.



Wide Firebox Consolidation Locomotive, Long Island Railroad.

MR. S. F. PRINCE, JR., Supt, Motive Power.

BROOKS LOCOMOTIVE WORKS, Builders.

double brace at the smokebox, having a central foot common to both braces, this foot being riveted to the smokebox just above the junction of the latter with the cylinder saddle. These braces extend front and back, the former going forward to the front of frame and the latter back to the guide yoke. This construction presents an odd appearance at this time because we have gradually outgrown the idea of the necessity for front end braces in the last few years, but there is no question of the value of these braces in relieving the saddle bolts of a considerable tendency to shearing.

An example of the certain passing of the extension front is to be noted on these engines; the fronts are fitted with the improved Bell spark arrester, and are only long enough to take in the cinder hopper, while the length is sufficient to admit the headlight in front of the stack, the lampboard being flush with the door ring. The construction of the reverse shaft is with one central lifting arm for the two link hangers. It is peculiar to the Brooks Works and a good plan. A safe stowage place for the main air reservoir is seen to be between the frames at the rear of the main drivers; the reservoir is slung by two stirrups that are secured to a casting resting on the frames. The use of the Wootten firebox on the Long Island is the result of the policy of the company to reduce the smoke nuisance as far as possible, and to that end locomotives recently overhauled have been fitted with this firebox. These engines have fireboxes 7 by 10 feet, and a total heating surface of 1,952 square feet. Our engravings show the general appearance and many of the detail dimensions of the engines.

On a dry rail they will exert a draw bar effort of 35,000 pounds. They are cylindered up to their adhesive weight; or, in other words, they do not carry any superfluous load on their drivers with the expectation of some day meeting with a slippery rail. This will be seen by the coefficient of adhesion of 0.261. It is notable, by the way, that the latest designs of heavy locomotives show a tendency toward a high coefficient, it being understood that the sanding devices can take care of an occasional adverse condition of rail. A description of these engines will be found below:

General Description.

Kind of fuel to be used.....	Anthracite and soft coal
Weight on drivers.....	135,000 pounds
" " trucks.....	20,000 pounds
" total.....	155,000 pounds
" tender, loaded.....	86,000 pounds

Dimensions.

Wheel base, total, of engine.....	32 feet 9 inches
" " driving.....	14 feet 6 inches
" total, engine and tender.....	49 feet 6 inches
Length over all, engine.....	35 feet
" total, engine and tender.....	60 feet 3/4 inch
Height, center of boiler above rails.....	8 feet 8 inches
" of stack above rails.....	14 feet 3 1/2 inches
Heating surface, firebox.....	179 square feet
" " tubes.....	1,773 square feet
" " total.....	1,952 square feet
Grate area.....	69 square feet

Wheels and Journals.

Drivers, diameter.....	51 inches
" material of centers.....	Cast steel
Truck wheels, diameter.....	30 inches
Journals, driving axle.....	8 by 10 inches
" truck.....	5 1/2 by 10 inches
Main crank pin, size.....	6 1/4 by 6 inches

Cylinders.

Cylinders, diameter.....	21 by 28 inches
Piston rod, diameter.....	4 inches
Main rod, length center to center.....	120 inches
Steam ports, length.....	18 inches
" width.....	1 1/2 inches
Exhaust " length.....	18 inches
" width.....	3 inches
Bridge, width.....	1 1/2 inches

Valves.

Valves, kind.....	Richardson balanced
" greatest travel.....	6 1/4 inches
" outside lap.....	3/4 inch
" inside.....	None
Lead in full gear.....	None

Boiler.

Boiler, type.....	Straight top
" working steam pressure.....	180 pounds
" thickness of material in barrel.....	11-16 inch
" " tube sheet.....	1 1/2 inch
" diameter of barrel.....	72 inches
Crown sheet, stayed with.....	Radial stays
Dome, diameter.....	30 inches

Firebox.

Firebox, type.....	Wootten over wheels
" length.....	120 inches

Firebox	width.....	84 inches
"	depth, front.....	61 inches
"	" back.....	58 inches
"	material.....	Steel
"	thickness of sheets—	
"	Tube, 1/2 inch; sides, top and back 3/8 inch	
"	Brick arch.....	None
"	mud ring, width—	
"	Back, 3 1/2 inches; sides, 3 1/2 inches; front, 4 inches	
Grates.....	Cast-iron shaking	
Tubes, number.....	264	
" material.....	Charcoal iron	
" outside diameter.....	2 inches	
" thickness.....	No. 11 B. W. G.	
" length over tube sheets.....	11 feet 7-15 inches	

Smokebox.

Smokebox, diameter, outside.....	75 inches
" length from flue sheet.....	63 inches

Other Parts.

Exhaust nozzle.....	Single	
" diameter.....	5 inches; 5 1/2-16 inches; 5 1/2 inches	
" distance of tip above center of boiler.....	1 inch	
Netting, wire or plate.....	Wire	
" size of mesh or perforation—		
" 2 1/2 by 2 1/2 inches, and 2 1/4 by 1 1/4 inches		
Stack, straight or taper.....	Steel taper	
" least diameter.....	15 1/2 inches	
" greatest.....	18 1/2 inches	
" height above smokebox.....	39 inches	

Tender.

Type.....	8-wheel, steel frame	
Tank capacity for water.....	4,000 gallons	
" " coal.....	8 tons	
" material.....	Steel	
" thickness of sheets.....	3-16 inch and 1/8 inch	
Type of underframe.....	Steel channel	
" springs.....	Half elliptic	
Diameter of wheels.....	33 inches	
" and length of journals.....	4 1/4 by 8 inches	
Distance between centers of journals.....	5 feet 4 inches	
Diameter of wheel fit on axle.....	5 1/2 inches	
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Length of tender over bumper beams.....	23 feet 6 inches	
" tank.....	20 feet	
Width " " not including collar.....	8 feet 7 inches	
Height " ".....	52 inches	

Special Equipment.

Brakes.....	American for drivers; Westinghouse for tender and train service.	
Pump.....	9 1/4 inches	
Sight feed lubricators.....	Detroit	
Safety valves.....	Prince	
Injectors.....	Sellers	
Spring.....	French	
Spark arresters.....	Bell's Improved	

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What would appear to be an excellent opening for the exercise of the inventive faculty is to be found in the want of a satisfactory braking system on street cars. The old crude devices used on horse cars is doing duty on electric cars, and while they were never good, they are now simply a reproach to those responsible for their use at this day, when a good brake is as much of a necessity in crowded street traffic as on a steam road. The numerous cripples and deaths resulting from the failure to provide a suitable brake have aroused the New York State Railroad Commission to action in the matter, and they have invited all those interested in power brakes to assist at a test of such brakes in New York city on the tracks of the Metropolitan Street Railway Company. The excuse for the continuance of the old hand-brake, namely, that no satisfactory power brake had ever been devised, will not satisfy the present inquiry, and we may now expect to see some improvement. Brake shoes should come in for a share of attention in this test, as they are exceedingly important in influencing the quickness of stops.

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FRICTION OF LOCOMOTIVE SLIDE VALVES.

Experiments upon the friction of locomotive slide valves conducted upon a locomotive on the Great Southern & Western Railway were described in a paper by Mr. J. A. F. Aspinall before the Institution of Civil Engineers (England) in 1889, and the information then given has been recently supplemented by another paper by him before the same organization. The experiments were tried with valves resting against a vertical face, on an inside-cylinder engine, the steam chest being between the cylinders. The author considered it possible that the friction of slide valves when resting upon a horizontal face might be somewhat different from that of valves resting upon a vertical face, and he also desired to test the advantages to be obtained from partial balancing. The following experiments were therefore carried out upon a Lancashire & Yorkshire Railway engine at Horwich, the engine being fitted with the Joy valve gear, Fig. 1. The recording apparatus was similar to that used in the experiments of 1889. Every

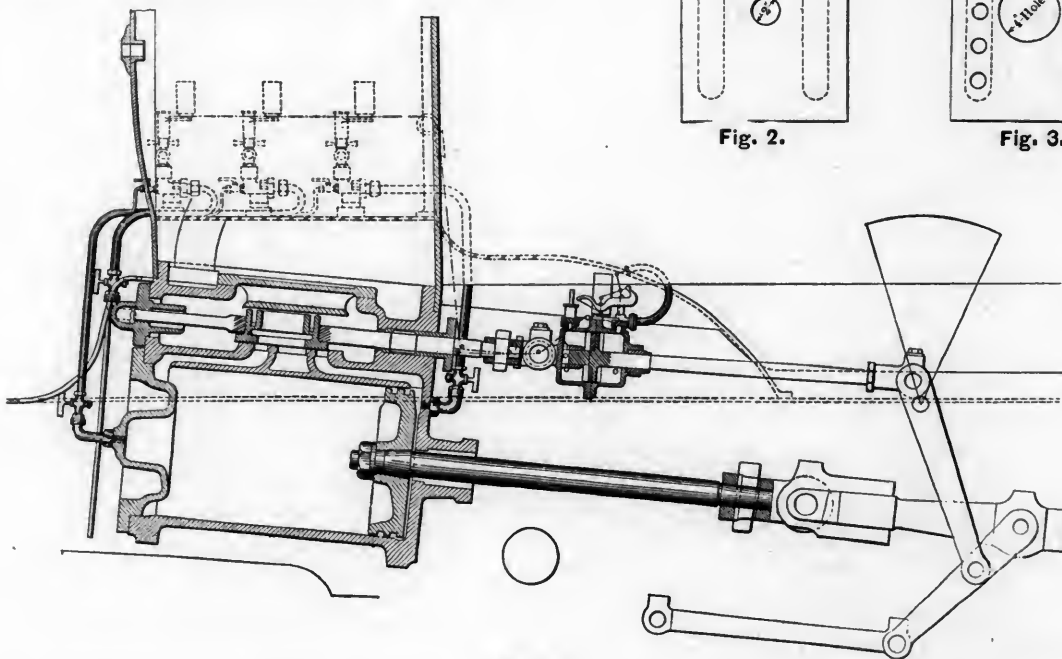


Fig. 1.

care was taken to calibrate the apparatus beforehand, and to ascertain the limits of error which could be allowed for in the final experiments.

In the 1889 experiments, the indicator diagrams, which were taken to show the work done in the engine cylinder at the same moment that the friction diagrams were taken from the dynamometer, were of the ordinary length, the motion being obtained by suitable mechanism from the piston cross-head; but in the present experiments the motion was obtained from the valve-spindle crosshead, this being considered a more accurate method of ascertaining the steam-pressure at any known position of the valve. It thus became easy to obtain a simultaneous record giving a friction diagram, a steam chest diagram and a steam cylinder diagram, thus eliminating any error that might have been present had these diagrams been taken one after the other.

The speeds at which the diagrams were taken varied between six and eight miles an hour. Two kinds of valves were experimented with; one, an ordinary D valve made of phosphor-bronze; and the other of the Richardson type, made of cast iron, with an open back; the fixed plate against which the valve slides being also of cast iron. The annexed table gives the leading particulars of the steam pressures and other points of importance; the coefficient of friction in each case being given in the last column. Thirty-one sets of diagrams were taken with the D phosphor-bronze valve, the average coeffi-

cient of friction being 0.0878, and six diagrams were taken of the cast-iron Richardson valve, the average coefficient of friction being 0.0919. In the partially balanced valve, the balance area was taken as being that portion which is enclosed between the strips, excluding the area of the strips themselves.

The good results obtained with the Richardson valves have caused the author to modify the views he previously expressed as to the advantages to be obtained from balancing. The experiments show that the friction of slide valves is somewhat greater against a horizontal than against a vertical face; the coefficient of friction found in the 1889 experiments for valves on a vertical face was 0.068, while in the experiments

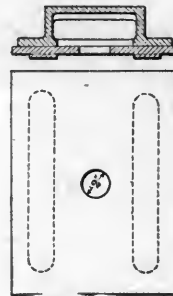


Fig. 2.

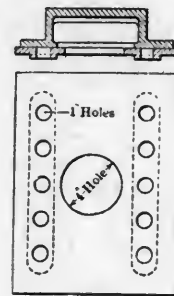


Fig. 3.

dealt with in the present paper the average coefficient was found to be for the unbalanced valve 0.0878, and for the partially balanced valve 0.0919. There is a considerable advantage in having to overcome a force of only 854.3 pounds for the balanced, as against a force of 1,946.18 pounds for the unbalanced valves.

In connection with the 1889 experiments, opinions have been expressed that the use of the whole of the area of the back of the D valve, when estimating the coefficient of friction, was erroneous, on the ground that the only area affected by the pressure in the steam chest was an area equivalent to that of the steam ports. The argument is that if a flat plate of the same superficial area as the back of the valve were moved over another plate in the steam chest, there would be no friction; but if the lower plate had a hole, say two inches in diameter, bored through it, the force required to move the flat plate would only be that due to the pressure of the steam multiplied by the area of the hole, and as this opening became greater, so the force required to move the valve would also become greater.

In order to test this question, an experiment was made on another engine of the same class. A cast-iron plate was laid upon the ordinary valve face, and through it a two-inch hole was bored. An ordinary phosphor-bronze unbalanced D valve worked upon it, and the same dynamometer and recording arrangements were used for these experiments as for those

recorded in the first part of the paper. With this arrangement, Fig. 2, it was found that a force of 2,195.9 pounds was required to move the valve with a pressure of 160 pounds per square inch in the steam chest. The plate was then taken out, and the two-inch hole was enlarged to four inches, and five one-inch holes were drilled over each of the steam ports, Fig. 3. The dynamometer recorded exactly the same force of

TABLE OF RESULTS.

Forward or Back Gear.	Notch, 1 to 4	Push or Pull	Lubrication	Type of Valve	Boiler Pressure.	Steam-chest Pressure.	Net Pressure on Valve	Total Force on Diaphragm, corrected.	Total Force Moving Valve.	Coefficient of Friction.
			Drops per min.		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
F.	1	Pull.	4	Phosphor-Bronze "D" Valve	156	155.0	24,149.0	1,549.5	2,099.0	0.086
"	1	"	4		152	151.5	23,562.5	1,539.0	2,126.0	0.090
"	2	"	4		158	154.0	23,405.0	1,510.5	2,056.5	0.087
"	2	"	4		157	153.0	23,037.0	1,497.0	2,039.5	0.088
"	3	"	4		144	137.0	19,513.0	1,090.0	1,575.5	0.080
"	3	"	4		154	150.0	21,619.0	1,562.5	2,094.5	0.092
"	4	"	4		146	140.0	19,455.5	1,234.0	1,730.5	0.088
"	4	"	4		158	150.0	21,077.5	1,392.0	1,824.0	0.091
B.	1	"	4		158	155.5	23,894.5	1,497.0	2,048.5	0.085
"	1	"	4		149	144.5	22,929.0	1,497.0	2,045.0	0.085
"	2	"	4		152	150.0	21,924.0	1,444.5	1,976.5	0.090
"	2	"	4		155	147.5	22,052.0	1,313.0	1,836.0	0.083
"	3	"	4		150	145.5	20,824.0	1,300.0	1,816.0	0.087
"	3	"	4		156	151.5	21,801.5	1,300.0	1,837.0	0.084
"	4	"	4		155	152.0	20,819.5	1,103.0	1,642.0	0.078
F.	1	Push.	3		147	140.0	19,248.5	1,129.0	1,625.5	0.084
"	1	"	6		160	157.5	24,461.5	3,326.0	1,767.0	0.072
"	2	"	3	Balanced	158	156.5	24,291.5	2,866.0	2,311.0	0.095
"	2	"	5		159	150.0	22,907.0	1,709.0	1,177.0	0.051
"	3	"	3		160	138.0	20,568.0	2,347.5	1,865.5	0.090
"	3	"	3		159	152.0	23,032.5	1,593.0	964.0	0.041
"	4	"	3		160	148.0	20,941.5	2,620.5	2,095.5	0.100
"	4	"	3		161	148.5	20,736.0	2,532.0	2,005.0	0.096
B.	1	"	3		160	147.0	22,502.5	2,973.5	2,452.0	0.108
"	1	"	3		158	152.0	23,732.0	1,915.0	1,376.0	0.057
"	2	"	3		158	142.0	21,184.5	2,826.5	2,322.5	0.109
"	2	"	3		164	160.0	23,605.5	3,328.0	2,758.5	0.112
"	3	"	3		158	147.0	21,292.5	2,914.5	2,393.0	0.112
"	3	"	3		160	150.0	21,677.0	2,944.0	2,412.0	0.111
"	4	"	3		158	140.0	19,995.0	2,468.5	1,972.0	0.098
"	4	"	3		160	145.0	21,165.5	2,503.0	1,988.5	0.093
"	1	Pull.	4		144	140.0	9,467.0	420.0	916.5	0.087
"	1	"	4		142	140.5	9,514.5	433.5	892.0	0.094
"	2	"	4		140	133.0	8,633.0	283.5	760.5	0.088
"	2	"	4		158	154.5	9,976.0	393.5	941.5	0.094
"	3	"	4		143	140.0	8,704.0	354.0	850.5	0.097
"	3	"	4		152	149.0	9,238.0	236.0	765.0	0.082

NOTE.—The regulator was full open in all the experiments.

2,195.9 pounds under these conditions. The intermediate plate was then removed and the valve was dropped upon the ordinary cylinder face, with the result that exactly the same force was found to be necessary to give movement to the valve. The author is of the opinion that this experiment disposes of the view that the area of the steam ports only should be taken into account. This is of interest, although the fact has been known for a long time in this country.

TAYLOR IRON.

Probably complete relief from anxiety with regard to the breaking of staybolts will never be had as long as fireboxes are made in the forms at present customary, but many believe that they reduce the amount of breakage of staybolts, and the danger from this source by the use of the best iron they can obtain. There are differences of opinion as to which of several irons is the best, and we are glad to note that there is a marked tendency toward discrimination in favor of improvement among railroad purchasers. With increased pressures not only do the repairs increase, but also the risks of being called into court to tell all about the quality of iron used for staybolts in sundry exploded boilers.

To make good staybolt iron the process must begin in the selection of the ore, and, while the entire process must receive the best of attention the results are probably affected most by the amount of "working" of the iron. "Taylor Yorkshire Iron" has long had an enviable reputation for excellence, and, what is more, uniformity of excellence. The makers use their own ore and keep such close check upon the manufacture, by aid of chemical and physical tests, as to render the records of some years ago a gauge of the present product. In proof of this we quote chemical analyses of May 27, 1895, March 1, 1898, and October 1, 1898, which were kindly supplied by Mr. F. E. Barnard of B. M. Jones & Co., of Boston, the agents of the manufacturers. These are as follows:

	May 27, 1895.	March 1, 1898.	October 1, 1898.
Carbon	Trace	None	Trace
Manganese	Trace	Trace	Trace
Silicon .....	.060	.140	.128
Sulphur .....	.021	Trace	Trace
Phosphorus .....	.100	.135	.137
Iron (by difference)	99.819	99.725	99.735

These tests were taken at random, and they fairly represent the reports received every week from the works. The physical properties appear to be not less uniform from the tests made on the United States Government testing machine at Watertown, in September, 1889, being representative now. Two samples from regular stock gave the following:

Elastic Limit.	Ultimate strength.	Elongation in 10 inches.	Contraction of area.
35,680	52,750	29.7%	53.3%
34,900	53,250	31.3%	54.1%

This staybolt iron is worked seven separate times, and that used for piston rods, crank pins and axles receives one additional heat for the "planish" working. The story of manufacture is told in the fact that nine tons of coal are used per ton of finished iron. The firm ships no billets, but finished material only, each piece of which is stamped, the axles being stamped at the center, where they are undisturbed in machining. No scrap is used, and Mr. Barnard tells us that from sales of about 200 piston rods per month less than five per year, as an average, are returned. Of a lot of 120 driving axles and 240 truck and tender axles furnished some time ago for 40 Mexican Central engines only one truck axle was discarded on account of defects when turned up.

The material has held the patronage of certain railroads for over 20 years, and now, with the increasing requirements in staybolts it appears to be making more friends than ever.

COAL CARS.

American vs. English.

The following comparative figures of the weights of cars and trains used in American and English freight practice, the authority for which is Vice-President Joseph Price of the Grand Trunk, an English gentleman thoroughly conversant with the minutest details of railroading on both sides of the Atlantic, are interesting. With reference to the superiority of American freight cars, he said that he did not doubt that the concentration of the load in our trains is conducive to greater economy in operation, and spoke of a test with which he was identified four years ago, made for comparative purposes, by hauling a coal train on the New York, Ontario & Western from Middletown to Weehawken, and on the London & Northwestern from Rugby to Willesden, the distance being exactly 77 miles in each case.

The English train was made up of 57 coal wagons, having a total weight of 852 tons, and the American train had 24 gondola cars, the loaded weight of which was 919 tons. The paying load per cent. of the English train was 51.71, and of the American 61.11. The English train was 1,263 feet long and the American 857. The former train had 130 axles and the latter 109. These data show the large capacity of the American cars to be advantageous, but some facts had to be considered which would prove that cars of American capacity could not be used on English roads. On this phase of the subject it was explained that American cars are 12 tons in weight, with a capacity of 30 tons of coal, but the cars capable of use for such tonnage have to be very much wider than the English "wagons." All of the American cars are fixed on trucks, and the bodies of the cars partly overhang the permanent way, and to introduce them into the English system all the bridges and tunnels would have to be widened, which is too serious a matter to contemplate; besides which the English turntables would all be too short for the American cars. It is thought these facts dispose of the possibility of adopting the American system on English railways. [There is no doubt that the mammoth proportions of our freight equipment preclude its introduction on roads whose station platforms, as well as bridges and tunnels, have been designed for the service of smaller cars, but we do not exactly comprehend the status of the turntables in the economy of freight service. The need of it is not a pressing one on this side.—Editor.]

CAR CENTER PLATES—LUBRICATED.

In the article on "Freight Car Center Plates" in our February issue reference was made to the advantages of lubricating them in reducing curve resistances. We now present the practice of the Lake Erie & Western, by courtesy of Mr. P. Reilly, Superintendent of Equipment, who recounts his experience with the plates he devised and patented for his freight equipment and shown in Fig. 1, as follows: "I have had these plates in service now for several years, and by observation I find that the cars fitted with them show very little or no flange wear. There is also a very noticeable decrease in the end wear of brasses, which is a sure indication that the cars curve easily

The value of the device being judged by the measure of success achieved, there is certainly little room for argument against lubricating center plates. Fig. 2 shows the cast steel center plate recently put in service on the Northern Pacific and also referred to in the article noted above. This plate, as will be seen, has a loose liner interposed between the upper and lower sections, the upper one of which forms a reservoir to contain the lubricant and has a perforated bottom face to allow the oil free access to the liner and lower plate. There is no information available of the performance of this center plate, which was devised for the heavy capacity cars, but it is fair to assume that it will reduce curve resistance as far as rough center plates are responsible for it.

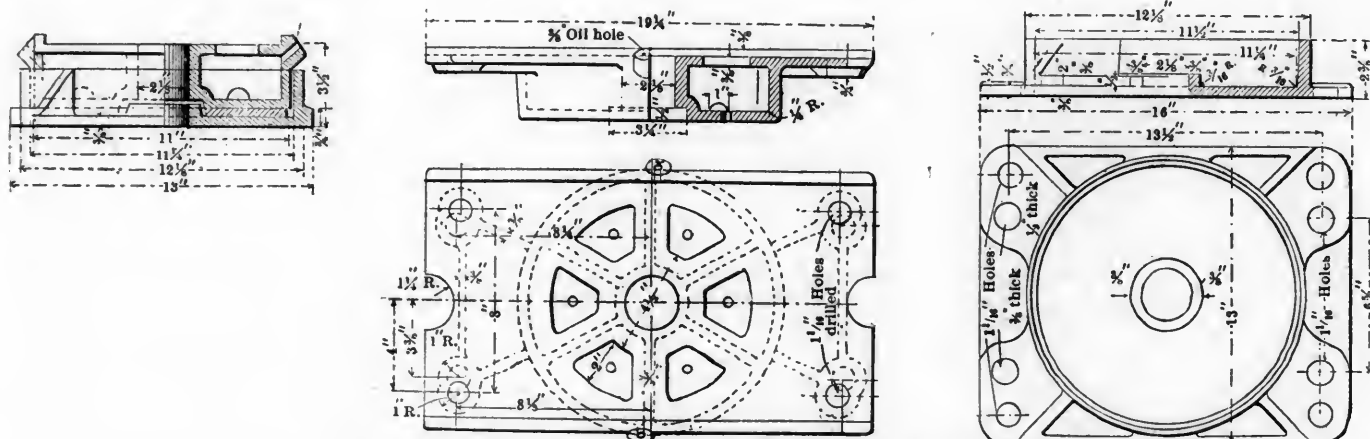


Fig. 2.—Lubricated Center Plates, Northern Pacific Railway.

and consequently the hauling capacity of the engine is increased. I equipped one special car with these plates over a year ago and did not see the car again until after it had run over the year. On examination the plates were found to contain enough of the original oil to run another year, and the wheels showed no wear on the flanges nor did the journal bearings show any end wear worth mention.

"Center plates for cars of 60,000 pounds capacity should be about 12 inches in diameter on the bearing surface. The oil reservoir will hold one pint, which will ordinarily run a car two years without attention from the inspectors or repairers. It is not the intention that these plates should be oiled every now and then, the same as car journals, for we all know they

Twelve new war vessels are recommended by the Naval Appropriation bill, reported to the House of Representatives February 8. Secretary Long, in his annual report, asked for 15 ships—three 13,000-ton battleships, three 12,500-ton armored cruisers, three 6,500-ton protected cruisers and six 2,500-ton cruisers. The bill, as reported, included all except the three 6,500-ton protected cruisers. The battleships will be seagoing, and will be sheathed and coppered; they will have the heaviest armor and armament of ships of their class, and the cost will be about \$3,600,000, exclusive of armor and guns. The armored cruisers will have three screws each, which is probably due to the opinion of Engineer-in-Chief Melville. They will also be sheathed and coppered, and will cost about \$4,000,000 each, not including armor and armament. The six small cruisers are to be built for high speed, without sacrificing features of cruising and long radius of action, and they will cost about \$1,142,000 each.

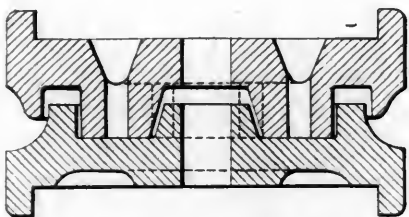


Fig. 1.—Lubricated Center Plates.
Lake Erie & Western Railway.

would not be looked after by car inspectors, but the construction is such that the oil is retained in the reservoir in the upper plate and cannot leak out. It is used as needed, but does not get away. It is readily seen that a small quantity of oil will last a long time. The lubricating idea is a very simple one; it relieves the friction of the center bearings and does it in an inexpensive way, and does not require any attention except when the car is in the shop for general repairs, or about once in two years."

This would appear to be a good indorsement of the lubricating of parts that have heretofore had no attention whatever.

PAY 10 CENTS TO SEE DR. DEPEW.

One of the privileges of being famous is to attract attention and it is sometimes profitable to recognize celebrated people. A good story is told of Chauncey M. Depew and President Callaway of the New York Central, who were "doing" the Omaha Exposition together, and happened to go into a "midway" booth.

It was a tame entertainment and there was only a meagre attendance when Mr. Depew and Mr. Callaway entered. Their stay would have been very brief except for the fact that they had scarcely taken their seats before there began a steady in-pouring of people, which continued until the small auditorium was crowded.

Taking this extraordinary increase of spectators as an indication that something of an interesting nature was about to be disclosed the two New Yorkers concluded to sit it out. Half an hour's waiting failed to reward their patient expectancy, however, and Mr. Callaway suggested that they move on.

Just then ex-Secretary of Agriculture J. Sterling Morton pushed his way through the crowd, and extending his hand to Mr. Depew, exclaimed:

"Well, Doctor Depew, so you are really here! I thought that 'barker' was lying."

"What do you mean?" inquired Mr. Depew.

"Why, the 'barker' for this show is standing outside and inviting the crowd to 'step up lively' and pay ten cents for the privilege of seeing the 'great and only Chauncey M. Depew.'"

McCORD SPRING DAMPENER.

The McCord dampener for helical springs, as shown in our illustration, is a device which apparently deprives that type of spring of its objectionable snappy vibrations and makes it possible to use helical springs with comfort and safety in places heretofore impossible by reason of their too great sensitiveness, such as, for example, tenders and passenger cars. The importance of this cannot be overestimated, for the reason that the question of economy also comes in for consideration, and the relative cost of helical and elliptic springs is such that if by a mechanical device the former can be made to do the work of the latter, there will be no doubt as to which spring to use.

These features of the question were thought out about eight years ago by Mr. Geo. Gibbs, at that time Mechanical Engineer

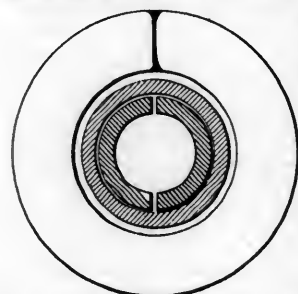
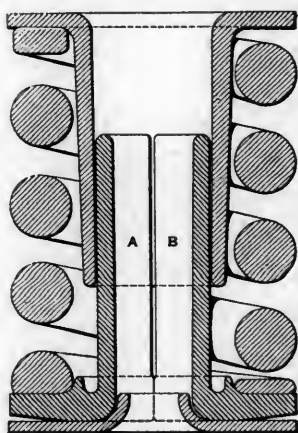


Fig. 1.—The McCord Spring Dampener.

of the Chicago, Milwaukee & St. Paul, and now Consulting Engineer of the Baldwin-Westinghouse combination. Mr. Gibbs was the pioneer in the attempt to dampen the vibrations of coil springs and change their motion to the soft movement of the elliptic spring, by a device entirely distinct and apart from the springs themselves. The McCord dampener, however, is a part of the spring mounting, consisting of two sleeves that form the upper and lower seats for the spring.

The lower of these sleeves is split so as to form two pieces where it enters the upper sleeve, which is a continuous piece. The flanged base of the lower, or split, sleeve is of spherical form, and the spring rests on the outer edge of the flanges. Here is the mechanical principle on which depends the success of the device as a dampener. When the load comes on the spring, the halves of the lower sleeve become a pair of bent

levers, owing to the spherical

contour of the base, and the

upper ends are thus forced out against the continuous sleeve

with an intensity proportional to the lever arms and the load,

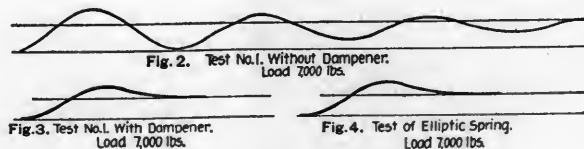
giving a frictional resistance between the sleeves that, under

shocks, causes a slow movement and brings the spring to rest

with but one vibration. This will be readily understood by

reference to the illustration, Fig. 1.

A comparison of the vibrations of helical and elliptic springs is nicely shown graphically in Figs. 2, 3 and 4, by means of



Tests of Spiral and Elliptic Springs.

diagrams obtained by the attachment of a revolving drum to a testing machine. The horizontal right lines were made on the diagram by causing the drum to travel under the pencil; the upper of these lines being made while the beam was in its normal position with no load, and the lower ones by depressing the beams until the spring came to a solid bearing, and then allowing the beam to vibrate with freedom. The resultant of these movements of the drum and beam is

the sinuous line shown in each figure. Fig. 2 represents a coil spring without a dampener, and therefore very active. Fig. 3 shows the effect of the dampener on the same spring, and Fig. 4 shows the normal action of a 36-inch, 5-leaf elliptic spring. These show plainly the effect of, and while highly gratified by these lines as bearing out their theory that the action of the helical spring is made equal in all respects, as shown in the diagram, to that of an elliptic spring, the owners of the device have found facts in practice to sustain all claims made for it. It has been in use on a tender for a long period, and the results are exactly what were expected. McCord & Company, of New York and Chicago, are the manufacturers and are prepared to furnish the device for service.

RAILWAY STATISTICS.

The statistician of the Interstate Commerce Commission has prepared summaries from the tenth statistical report for the year ending June 30, 1897, from which we make some extracts of interest. Of railways we find that of the total of 184,428.47 miles, there were 128 roads in the hands of receivers. These roads operated 18,861.68 miles, the mileage owned by them being 14,894.57 miles. These figures, as compared with those for 1896, show a net decrease of 11,613.71 miles operated, and 8,622.89 miles owned by roads in charge of receivers. During the year ending June 30, 1897, 51 roads were removed from the control of receivers, and 28 roads were placed under their management. An inspection of the roads operated under receiverships on June 30, 1897, shows that 22 operated a mileage in excess of 300 miles; 20 between 100 and 300 miles, and 70 a mileage less than 100 miles.

Equipment figures give the total number of locomotives in service on June 30, 1897, as 35,986, an increase in number over the previous year of 36. Of the total number of locomotives reported, 10,017 were classed as passenger locomotives, 20,398 as freight locomotives, and 5,012 as switching locomotives. The number of locomotives without classification was 469. The total number of cars of all classes reported in service on the date named was 1,297,480. The corresponding number for the previous year was 169 greater. Of the total cars reported, 33,626, or 623 more than for 1896, were assigned to passenger service; 1,221,730 were assigned to freight service, indicating a decrease of 157 during the year; and 42,124 were assigned to the special service of the railway companies. This record does not include cars owned by private companies and individuals that are used by railways in transportation service.

Taking the United States as a whole, it appears that 48,861 passengers were carried, and 1,223,614 passenger miles accomplished per passenger locomotive, and correspondingly there were 36,362 tons carried and 4,664,135 ton-miles accomplished per freight locomotive. All of these items show a decrease as compared with those of the preceding year. The number of passenger cars per 1,000,000 passengers carried during the year under consideration was 69, and the number of freight cars per 1,000,000 tons of freight carried was 1,647. It should be understood, however, that this average does not include such cars, mainly in the freight service, as are owned by private parties, for the use of which the railways paid during the year approximately \$11,000,000. Including in the term "equipment" both locomotives and cars, it is found that the total equipment of railways on June 30, 1897, was 1,333,466. These figures are 133 less than on June 30, 1896. Of this total number 525,286 were fitted with train brakes, the increase being 76,432, and 678,725 were fitted with automatic couplers, the increase in this case being 133,142. These increases are somewhat smaller than the corresponding increases for 1896.

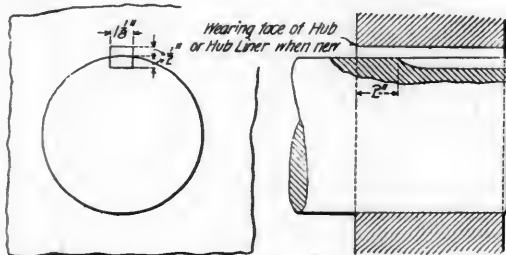
Further equipment details on June 30, 1897, show that the number of passenger locomotives fitted with train brakes was 9,899, or 83 more than the preceding year. The number of freight locomotives so fitted was 18,796, or 875 more than the preceding year. The number of switching locomotives fitted with train brakes was 3,666. The number of passenger locomotives fitted with automatic couplers was 4,687, the increase with respect to 1896 being 184. The number of freight locomotives fitted with automatic couplers was 4,192, the increase being 819. The number of switching locomotives fitted with such couplers was 741, or 147 more than for 1896. The number of passenger cars fitted with train brakes on June 30, 1897, was

33,078, and the number fitted with automatic couplers was 32,661, the increase being 665 and 815 respectively. The number of cars in freight service fitted with train brakes was 453,688, or 74,630 more than in preceding year. The number fitted with automatic couplers was 629,399, indicating an increase of 129,166. Of the total cars in service 492,559 on June 30, 1897, were fitted with train brakes, and 668,937 were fitted with automatic couplers, the increase for the year in the former case being 75,237, and in the latter 131,989.

The number of men employed by the railways of the United States on June 30, 1897, was 823,476. These figures, assigned on the mileage basis, show 449 men per 100 miles of line. The corresponding figures for the preceding year were slightly larger. The employees of railways are divided into 18 classes. The number of station agents was 30,049; other station men, 74,569; enginemen, 35,667; firemen, 36,735; conductors, 25,332; other train men, 63,763; switchmen, flagmen and watchmen, 43,768, and telegraph operators and dispatchers, 21,452. A distribution of employees corresponding to the four principal divisions of the classifications of operating expenses shows that general administration required the service of 31,871 employees, or 17 per 100 miles of line; maintenance of way and structures, 244,873, or 134 per 100 miles of line; maintenance of equipment, 160,667, or 88 per 100 miles of line, and conducting transportation, 378,361, or 206 per 100 miles of line. This statement disregards a small number of unclassified employees amounting to 7,704. For the year ending June 30, 1897, it appears that the aggregate amount of wages and salaries paid was \$465,601,581. This amount represents 61.87 per cent. of the total operating expenses of railways, or \$2,540 per mile of line. The total compensation for 1896 was \$3,222,950 greater.

DRIVING AXLE KEY-WAYS.—ERIE RAILROAD.

To the end of securing immunity from fracture of driving axles at the hub, more attention is given to construction detail at that point than formerly, in which not only the wheel fit, but the key-way are important factors. The practice of the Erie in this regard is shown herewith by courtesy of Mr. A. E. Mitchell, Superintendent of Motive Power. The wheel fit is of the same diameter as the journal. The method of key-way construction is new, and is no doubt a great improvement, for the reason that there is no starting point for fracture, as that portion of the key-way cut in the axle ends two inches from the inner face of the wheel, and has the most advantageous form for pre-



Method of Cutting Key Ways in Driving Axles—Erie Railroad.

serving the strength of the axle by its curvature of large radius. This, of course, is as beneficial to the wheel hub as to the axle in preventing the starting of an incipient crack. In our issue of May, 1898, the method of key fitting on the Chicago, Burlington & Quincy was shown, in which the inner end of the key-way is curved to a radius of 2 11-16 inches, but it extends 1 inch past the shoulder of the wheel fit into the journal. These are good examples of needed improvement in key-way cutting.

A novelty in train robbery is reported from France. A passenger was riding from Bordeaux to Paris alone in a compartment, and was beginning to doze, when he perceived a strange odor, which awoke him just as a man tried to open the door. On pulling the alarm bell cord the man disappeared, and it was found that a tube had been passed from the next compartment through a hole in the partition and chloroform was passed through the tube. We cannot forbear remarking that foreigners often pay well for their exclusiveness in traveling.

COMMUNICATIONS.

SHORT SMOKE BOXES FOR LOCOMOTIVES.

Editor American Engineer:

I have been expectantly waiting for the advocates of long smoke boxes to defend their position in reply to the descriptive article on short smoke boxes in your December paper of last year, but apparently they are now all in the business of changing to short fronts because of their silence. I have always held the opinion that the smaller the smoke box the better the influence of the draft upon the fire and that this is because the exhaust from the nozzle causes a dilation of the gases in the smoke box due to the vacuum produced by the blast. Now it is this vacuum that causes the draft through the tubes from the firebox and these gases rush into the smokebox to fill the spaces that were occupied by the gases driven out by the blast. The degree of dilation of the gases in the smoke box will be greater as the smoke box volume is made smaller and in consequence of this the smaller smoke boxes will produce better draft on the fire, the action of the exhaust being the same. To put this in a brief and clear way I should say that for any given condition of exhaust action the smaller the cavity in the smoke box the stronger the vacuum will be in it and the more energetic the effect upon the fire. This means that larger nozzles may be used with short front ends and this is very desirable. I would like to know if I am wrong in regard to this idea of the vacuum.

S. M. P.

Feb. 14, 1899.

[We think this view is correct and would like to hear from any one who has data to confirm the opinion. We have no such data, but we know of 19 by 24 inch moguls with the Bell front end that are running with 4 1/2-inch nozzles while similar engines with extension fronts are running in the same service with 4 1/2-inch nozzles. The division master mechanic in charge of the engines informs us that the short fronts are saving fuel, but no comparative tests have thus far been made. It seems unnecessary to argue the question of fuel saving in this case, because if the nozzles are opened a half inch and the engines do the same work as before, there must be a saving of fuel.—Editor.]

CAR CONSTRUCTION.

Editor "American Engineer:"

In your January issue I note some editorial comments on a paper read by Mr. F. M. Whyte at the recent meeting of the Western Railway Club, and desire to say that a sense of gratification was the dominant one before finishing the article for the reason that the views therein expressed are sound from a mechanical standpoint. The important lesson conveyed in the paper is that the rule of guess work in car design is nearing its end, and this is the more convincing because there are no propositions made that will not bear investigation. The assumption that a bolster should be made stiff enough to carry the load clear of the side bearings has often been made, but as far as my knowledge of the subject goes, I have never before been told how to design it so as to keep the bending moments where they could do the least harm, and therefore leave the bolster in the best condition to resist the stresses brought to bear on it.

The analyses of the stresses at work to produce deflection of the bolster are interesting, and while fairly well understood by the advanced car man, should be considered as a valuable part of the general contribution to the light thrown on the subject. This applies also to the location of the truss rods and their influence on the strength of the bolster, yet there will doubtless be cars constructed in the future with the outer truss rods as near to the outside sill as they can be placed, notwithstanding the evil effect of such location is plainly pointed out, so slow is the process of evolution. The recommendations of the paper in this regard are worthy of more than passing note, since they make it plain that the nearer the center the car the rods are placed, the shorter becomes the lever arm of the load on these rods, and the less the bending moment at center of bolster.

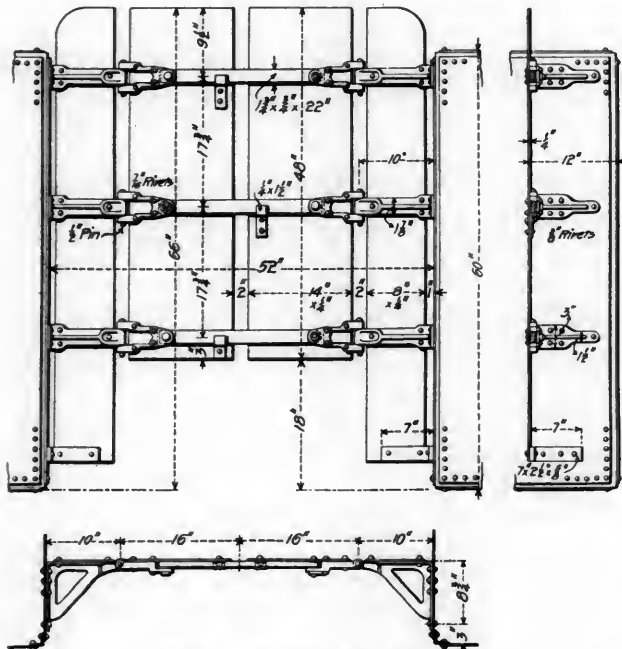
The suggestions as to needle beam bearings on the sills, and their office in transmitting a part of the load that properly belongs to the center sills, to the truss rods and through them

The restaurant is to be 80 by 80 feet, and a part of it will be used as a waiting room until the latter is fully completed. The lobby will be 550 feet long and 60 feet wide, and will be finished in staff in the same tasteful way as the waiting room. The increased size of the train shed will enable the company to dispatch about 25 per cent. more trains than formerly and in a more satisfactory manner than ever before. To provide this length of 777 feet in the train shed, it will be necessary to move the entire eastern end of the old shed 125 feet toward the river, which will give that amount of room to be utilized in the total length. This, it will be seen, involves a nice bit of engineering. The whole station will, it is estimated, cover when completed, about six acres.

METAL COAL GATE FOR TENDERS.

New York, Chicago & St. Louis R. R.

The coal gate for locomotive tenders which is illustrated here was designed with a view of using a permanent construction to save the continual expense and annoyance of keeping wooden gates in repair. These metal gates are supported by neat and strong hinges and brackets, which may be made of malleable



Metal Coal Gate for Tenders.
N. Y., C. & St. L. Ry.

iron, and they are held against the thrust of a load of coal by three substantial cross bars of $\frac{3}{4}$ by $1\frac{1}{4}$ inch iron fitting into suitable sockets. We are indebted for the drawing to Mr. John Mackenzie, Superintendent Motive Power of the New York, Chicago & St. Louis R. R., who is now using this plan with very satisfactory results.

STORAGE BATTERY LOCOMOTIVE IN FRANCE—PARIS, LYONS & MEDITERRANEAN RAILWAY.

Our readers are familiar with the Heilmann locomotive, and will be interested to know of a new electric locomotive, recently described in "La Nature." This one makes use of storage batteries, and was built under the direction of M. Baudry, Chief Engineer of the Paris, Lyons & Mediterranean, for use on that line.

The locomotive was built in the latter part of 1897, and has been used experimentally on the line between Paris and Melun. It has three axles, two of which are drivers, and has about one-half the power of the ordinary express locomotives on that road; but it would suffice to double the number of driving axles to give it the normal power of the ordinary locomotive. This locomotive is followed by a tender carrying storage batteries, the hauling of which absorbs a considerable part of its power on account of their great weight, and this would be unnecessary if the third rail or overhead trolley were employed. The driving and carrying wheels are 1.1 meters in diameter. The front compartment of the locomotive is depressed so as not to interfere with the view from the engineer's cab. The cab contains an air compressor operated by a small electric motor of five horse power which furnishes compressed air for the Westinghouse brakes, for the whistle and for the regulating apparatus. The three other compartments, two situated at the right and one at the left, are one meter high and contain each nine cells of storage battery. These are connected in series and serve to excite the fields of the compressor motor and furnish the current necessary for the air compressors and for the electric lighting of the cab, etc. The cells may also be employed to run the locomotive itself at low speed. The middle

compartment contains a large water rheostat controlling the large motors on the driving axles.

Current is furnished by two main storage batteries of 96 cells each carried on the tender. The normal strength of current in regular operation is 700 amperes, being equivalent to 300 horse power at a speed of 500 revolutions, equivalent to 103 kilometers per hour. Under these conditions, the difference of potential at the brushes is 360 volts. The capacity of the eighteen cells carried on the locomotive proper is 1,500 ampere hours. The plates of a cell represent a weight of 140 kilograms. The total weight of the locomotive is 44,500 kilograms, 12,500 of which rest on the first leading wheels, and 16,000 kilograms on each of the two main drivers. The total weight of the tender is 45,800 kilograms. The storage batteries number 192 and are able to deliver 1,000 ampere hours at the rate of 500 amperes. The armatures are built on the Brown system, the conductors being enclosed in the iron of the armature. Their diameter is 0.690 and their length 0.540 m.

Its first trip was made on Nov. 26, 1897, between Paris and Ville-neuve-St. Georges, with only 48 storage cells in the tender. Since then it has made a number of trips between Paris and Brunoy with 48 cells; then between Paris and Melun first with 100 cells, and finally with its complete equipment of 192 cells. The maximum load hauled between Paris and Melun was 147 tons, including the tender on the locomotive at the speed of 45 kilometres per hour. In lowering the load hauled to 100 tons the speed of 62 miles per hour was reached, corresponding to an effective power of 611 horse power.

GASOLINE ENGINES FOR RAILROAD USE.

The Boston & Maine has reduced the cost of pumping water at Barrie Plains, Mass., to $\frac{3}{4}$ cent per 1,000 gallons by the use of a gasoline engine, the best record of steam for the same conditions of lift having been 7 cents for the same unit.

The New York Central has installed a gasoline engine for hoisting ice, and the Illinois Central is using a gasoline engine combined in one bed with an air compressor at the bridge over the Salt River at West Point, Kentucky, we understand, for pneumatic riveting.

A combined air compressor and gasoline engine is now being fitted up in a box car at the South Union station in Boston for use in operating a sand blast and a paint spraying machine for use along the line of the New York, New Haven & Hartford.

CHINESE ORDER FOR 81 LOCOMOTIVES.

A dispatch says the Baldwin Locomotive Works, Philadelphia, have just closed a contract for the building of 81 locomotives, one of the largest single orders ever received by that company. The locomotives are for use on new railroads now under construction in China. The contract was under consideration about a year ago, but the breaking out of the war with Spain caused doubt regarding the safe delivery of the engines, and the matter was dropped for the time. Over \$800,000 is involved in the work, and the Baldwin Company will rapidly push construction.

M. C. B. AND M. M. CONVENTIONS.

The Master Car Builders' Association will hold its 33d annual convention at Old Point Comfort, Va., at the Hotel Chamberlain, beginning June 14, 1899. The Master Mechanics' Association will open its 32d annual convention at the same place on Monday, June 19. The Chamberlain and the Hygea hotels have joined in making rates for attendants at the conventions.

A very large gas engine plant which "Engineering" says is probably the largest in existence, is to be installed at the Lots' road pumping station of the London County Council. The plant will include 8 double cylinder horizontal Crossley gas engines, four of them rated at 260 I. H. P. each, and the other four at 210 I. H. P. Four 5 H. P. gas engines combined with air compressors complete the engine plant. The engines will use coal gas.

"Wait a While," a railroad station in New South Wales, has just won a fight to retain its name, which the railroad company wished to change.—"Scientific American."

DISHONEST SHIPPERS.

A curious case of swindling on the part of a shipper has recently been unearthed by the Interstate Commerce Commission, which exemplifies the ease with which competition may be overcome when leverage of this kind is applied. The particulars are as follows:

Complaint had been informally made to the Commission that some concerns engaged in selling turpentine in the South were making a lower price on their product than other dealers in the same line. An inquiry developed the fact that a large company engaged in the turpentine and petroleum trade had built a large number of tank cars adapted for the transportation of oils, and had certified to the railways that the full capacity of the tank cars was 6,000 gallons, and this was the capacity entered in the tank-car gage book issued by the Central Traffic Association.

The rate schedules filed by the Commission under Section 6 of the statute provide that oils carried in tank cars shall be charged for transportation according to the full capacity of the tanks, irrespective of the quantity of oil actually shipped. Investigation brought out the fact that the true capacity of these tank cars was 6,500 gallons, and not 6,000 gallons, as the owner and shipper had certified to the railroads. Turpentine being rated at seven pounds per gallon, the shipper had the advantage of 3,500 pounds free haulage for each car. The shipments were from Savannah, Ga., and Pensacola, Fla., to Chicago, Cleveland, Detroit and St. Louis, and, since these cars were returned South, laden with petroleum, competition was made to languish until the scheme was nipped in the bud by the Commission. It would be interesting to know to just what extent the culprits were amenable to the law, and, if accountable, what has been done about it.

TRAIN LIGHTING ABROAD.

In certain portions of Europe train lighting is just now attracting the attention of those governments which regulate such matters paternally. Russia, for example, has formulated a ukase that passenger trains must be lighted from electric accumulators. First class carriages must have a lamp of 100 candle power, second class carriages 80 candle power, and third class carriages 50 candle power. Besides these provisions, the lamps must be supplemented in compartments by candles, for use in case the electricity fails to work. France is making regulations for train lighting in tunnels. An old rule was operative only where a tunnel was 1,300 ft. long or over. The new Minister of Public Works thinks the time taken to pass through a tunnel should be the governing factor, and not the distance, and that functionary has handed down an opinion that a new rule should be promulgated by which a passenger could not be forced to remain in darkness more than 30 seconds at one time. Public opinion and competition regulates the light question in this country, but, of course, such little things are powerless over there. It would seem as though that ought to be a good field for the application of car lighting apparatus.

PERSONALS.

Mr. S. F. McLeod has been appointed Purchasing Agent of the Duluth, Missabe & Northern, with office at Duluth.

Mr. G. M. Beach has resigned as Assistant General Manager of the Pittsburgh & Lake Erie, on account of poor health.

Mr. Joseph Geimer has been appointed Master Mechanic of the Maricopa, Phoenix & Salt River Valley R.R. at Phoenix, Arizona.

Mr. J. S. Thurman has resigned as Mechanical Engineer of the Missouri Pacific, to give his attention to his pneumatic inventions.

Mr. Samuel Sloan was elected for the 35th time as President of the Delaware, Lackawanna & Western, at the recent annual meeting.

Mr. P. D. Plank has been appointed Master Mechanic of the Louisville, Henderson & St. Louis Railway, vice Mr. D. Vanalstine, resigned.

Mr. Charles Parsons has resigned the presidency of the Ogdensburg & Lake Champlain, and is to be succeeded by Mr. Percival W. Clement.

Mr. S. Phipp, formerly Road Foreman on the Canadian Pacific, has received the appointment of Assistant Master Mechanic, with headquarters at Winnipeg.

Mr. G. H. Goodell has been appointed Mechanical Engineer of the Northern Pacific, leaving a like position on the Erie, where he is succeeded by Mr. Howard Williams.

Mr. J. S. Chambers, formerly Superintendent of Motive Power of the West Virginia Central & Pittsburg, is appointed Master Mechanic of the Buffalo Division of the Lehigh Valley, at Buffalo.

Mr. John Lundie has received the appointment of Consulting Engineer for the Boston Elevated Railway Company. Mr. Lundie was formerly connected with the Chicago suburban lines of the Illinois Central.

Mr. C. Skinner has been appointed Master Mechanic of the Toledo, St. Louis & Kansas City at Frankfort, Ind., succeeding Mr. F. J. Pease, resigned. Mr. Skinner was formerly Master Mechanic of the Alabama Great Southern.

Mr. John J. Ellis, for several years at the head of the machinery department of the Chicago, St. Paul, Minneapolis & Omaha, with the title of Master Mechanic, has been made Superintendent of Motive Power and Machinery.

Mr. M. S. Curley, Master Mechanic of the Illinois Central at Water Valley, Miss., has been transferred to Paducah, Ky., in charge of mechanical matters on the Louisville Division and the Fulton district of the Memphis Division. He succeeds Mr. W. Hassman, resigned.

Mr. Arthur Leonard, for a number of years private secretary to Mr. H. Walter Webb while Vice-President of the New York Central, and later identified with the motive power department of the New York Central, has been appointed assistant to President Spoor of the Chicago Terminal.

Mr. W. H. Welch, Supervisor of the Elmira & Canandaigua Division of the Pennsylvania, has refused an offer of the position of Inspector of Railroads, under the New York Board of Railroad Commissioners at a salary of \$3,000, although this is much more than his present salary on the Pennsylvania.

Mr. W. P. Coburn, formerly Assistant Master Mechanic of the Chicago, Indianapolis & Louisville, has been promoted to the position of Master Mechanic, made vacant by the resignation of Mr. Henry Watkeys. Mr. Charles Collier, formerly Master Car Builder of this road, has received the appointment of Assistant Master Mechanic in charge of car work.

Professor J. B. Johnson, of Washington University, St. Louis, has resigned, to become Dean of the College of Mechanics and Engineering of the University of Wisconsin. He has earned a world-wide reputation by his original investigations, particularly in the subject of the strength of timbers and by his writings on the subject of the strength of materials.

Mr. W. H. Truesdale, First Vice-President and General Manager of the Chicago, Rock Island & Pacific, has resigned, to succeed Mr. Sloan in the Presidency of the Delaware, Lackawanna & Western, March 1st, with office in New York. Mr. Truesdale is one of the best and most favorably known railroad men in the West, and his place in the management of the Rock Island will be very difficult to fill.

W. S. Calhoun, who represented the American Steel Foundry Company as General Eastern Agent, died suddenly of pneumonia at Macon, Ga., Tuesday, Feb. 14, and was buried in Chicago. Mr. Calhoun at different times represented several very prominent railroad supply firms and he obtained a large part of his extensive acquaintance while connected with the Chicago Tire & Spring Company. He lost his health several years ago and spent some time in traveling, after which he took a position with the Brussels Tapestry Company. He was very successful, particularly in connection with the business of the American Steel Foundry Company, and he will be missed, especially by railroad and supply men, among whom he had a great many friends.

Mr. J. D. Layng, who has been Vice-President and General Manager of the West Shore Railroad since 1884, has tendered his resignation, which will be effective August 1, and he will retire with well-earned laurels. Mr. Layng has been in railroad service since 1849, beginning as a rodman on the Ohio & Pennsylvania. He was Superintendent of the Eastern Division of the Pittsburg, Fort Wayne and Chicago Railroad from 1865 to 1871, and General Manager of the Pennsylvania lines from 1874 to 1881. His connection with the West Shore dates from the time of its royal battle for existence against the New York Central, where he has remained to manage its operation since. August 1 will complete fifty years of active railroad life. After April 1 the West Shore management will be consolidated with that of the New York Central.

Mr. William E. Baker, who has just left the Metropolitan Elevated of Chicago, to become General Superintendent and Chief Electrical Engineer of the Manhattan Railway of New York, has been closely identified with the development of electric railroads, and especially with this power as employed upon elevated roads. He designed and installed the Intramural electric railroad at the World's Fair in Chicago, and afterward designed and installed the electric equipment of the Metropolitan and became General Superintendent of that road at its opening. He is 42 years of age, and received his education in Lafayette College. After spending a number of years in the engineering departments of several of the most important of the railroads in the Northwest, he entered the employ of the Thompson-Houston Co., for whom he installed the electric equipment of the West End Street Railway of Boston. Upon its completion he took charge of the Intramural in Chicago. Mr. Baker's appointment in New York is believed to be an indication of the policy of the Manhattan to immediately take up the change from steam to electric traction.

Mr. Godfrey W. Rhodes, whose change from the head of the mechanical department of the C., B. & Q. to accept the position of Assistant General Superintendent of the Burlington & Missouri River we noted last month, has earned the distinction of being one of the leading motive power officers of the time. It will not seem at all natural to think of him as in any other position than that which he has filled so ably and so long, and the American Engineer desires to protest if this change means that he will take a less active part in mechanical matters in which his opinions have such weight. The Master Mechanics' and the Master Car Builders' Associations never had more faithful and conscientious support, assistance, wise counsel and intelligent advice than that given always modestly, always fearlessly, disinterestedly and sincerely by Mr. Rhodes, and always for the good of the associations and for the railroads of this country. Being a successful motive power superintendent and possessing, as he does, excellent organizing ability, he will bring unusual experience to bear on transportation questions and intimate knowledge of motive power matters, notwithstanding their importance, is not too common among transportation officers.

Mr. F. A. Delano's appointment to succeed Mr. G. W. Rhodes as Superintendent of Motive Power of the Chicago, Burlington

& Quincy, was briefly noted last month. Mr. Delano is but 35 years of age, and has been connected with the Burlington for about 14 years. He entered the shops of the mechanical department at Aurora, and after serving apprenticeship, took charge of the Bureau of Rail Inspection and Tests, where he did very important work, which is reflected at the present time in the good condition of the tracks of the road. He was afterward made Assistant to the Second Vice-President, and in July, 1890, he was appointed Superintendent of Freight Terminals in Chicago, the position which he has just left to take charge of the motive power department. Mr. Delano is a graduate of Harvard University and combines education and a varied, yet concentrated, experience with good business and executive ability. He has the advantage over many motive power men in having a thorough knowledge of road and transportation, as well as motive power subjects. It is becoming unusual for a superintendent of motive power to be succeeded by a man on his own road which is an additional reason for congratulating the Burlington and Mr. Delano.

ELECTRIC RAILWAYS IN GERMANY.

Consul W. K. Anderson writes that up to the end of the year 1891 the number of cities in the German Empire enjoying the advantages of electric street railways was three; up to the end of 1892, five; 1893, eleven; 1894, nineteen; 1895, thirty-two; 1896, forty-four; 1897, sixty-one; and on the 1st of September, 1898, no less than sixty-eight. In thirty-five other cities or districts, railways are in the course of construction or finally determined upon. The entire length of electric lines in operation in Germany on Sept. 1, 1898, was 888 miles, and the total trackage was 1,205 miles. The number of motor cars was 3,190, and the number of trailers 2,128. The length of the new lines in course of construction or about to be begun at that date was 677 miles, and their total trackage 830 miles.

Most of the large industrial cities in Westphalia and the Rhine Province are connected by a network of electric roads, which serve not only for passengers, but for freight traffic.

The electric street railway of Hanover was built under the supervision and direction of an American from Philadelphia, and was opened for business on May 1, 1892. It was one of the first electric lines inaugurated in Germany, and is now one of the best systems in existence. The cars are modeled after our American ones, and the tracks are of heavy steel, laid on a substantial foundation of concrete. The fare for a course of, say, 2 miles within the city limits is 10 pfennigs, or less than 2½ cents of our money. Universal transfers are granted. The speed is about 8 miles per hour, and the cars run smoothly and with but little noise. Within the mile circuit and upon some of the principal streets extending to the city limits, the cars are run on the accumulator system; but when the outskirts are reached, the accumulators are released from service and the cars are run by overhead trolley. The lines extend, on almost every road, miles into the surrounding country. The trackage of the Hanover Electric Railway now amounts to over 105 miles. The equipment consists of 41 overhead trolley cars, 161 accumulator and trolley cars combined, 167 trailers, 20 locomotives, 4 sprinklers, and 24 freight cars. There are six power stations, four of which furnish, in addition to power for the cars, electric light for streets and roads. The motor cars are from 17 to 34 horse power, and the locomotives 50 horse power.

EQUIPMENT AND MANUFACTURING NOTES.

The Jackson & Sharp Company of Wilmington, Del., have an order for 16 coaches and 4 combination cars for the Philadelphia & Reading.

The Pennsylvania Steel Co. made the lowest bid on the New Orleans dry dock, their proposal being \$810,000, which is \$40,000 below the maximum price decided upon by the government.

The Union Pacific has ordered 40 10-wheel and 8 12-wheel simple locomotives from the Brooks Locomotive Works. The 10-wheelers will weigh 165,000 pounds, and will have 20 by 28-inch cylinders, and the 12-wheelers will weigh about 200,000 pounds in working order, and the cylinders will be 21 by 30 inches.

The Baldwin Locomotive Works are now setting up a new steam motor car for the Pennsylvania. It will have a speed of 40 miles an hour, and carry sufficient coal to run 50 miles. It is designed to meet the competition of electric roads.

The Pressed Steel Car Co., which is a consolidation of the Schoen and Fox interests, has received an order for 1,000 steel cars from the Union Pacific. The cars will be of the hopper and gondola type, and of 80,000 pounds capacity.

Mr. Henry L. Leach, North Cambridge, Mass., sold 318 sets of the Leach locomotive sander during the month of January, which number is 63 larger than the best previous record. The list includes orders from all of the prominent locomotive builders and many of the most important railroads.

An unprecedented rush of business is being enjoyed by the Brooks Locomotive Works, and requires the employment of 1,640 men in the different departments, which is 300 in excess of the number engaged at this time last year. The works are being run night and day. The important additions that are being made to the shops will probably be finished early in March.

The American Impulse Wheel Company of New York reports some very large electric transmission work in hand and most valuable results from all their installations. The company is increasing an already large home and export trade.

The Egyptian Government is reported as contemplating a steel car equipment for service on the Soudan Railroad, which is to ultimately connect Alexandria with Cape Colony, but Khartoum is to be the present terminus. From Cape Colony a road is now under construction toward the Zambesi country; this road is to embrace Rhodesia; it will cross the Zambesi River, and from there proceed to Khartoum. The Schoen Pressed Steel Company has, we understand, had an opportunity to furnish the steel equipment required for this road in the Dark Continent.

A recent issue of "Indian Engineering" referring to a prospective purchase of locomotives, says: "There is a probability of a new departure being taken by the Government of India in the matter of providing railway locomotives. An order for several engines is likely to be placed with American firms, as the makers in England are so busy that they cannot undertake to complete Indian orders within a reasonable time. The Central Bengal Railway Company has already tried American locomotives, which have given every satisfaction."

The recent order of the Baltimore & Ohio Railroad for five thousand steel coal cars, to be built by the Pressed Steel Company brings the total purchases of the receivers of the Baltimore & Ohio Railroad up to 30,394 since March 1, 1896. The locomotive purchases during that time have been 216, of which about 20 are still to be delivered. The company has also purchased five postal cars, ten express cars, ten combination cars and six dining cars.

Mr. E. P. Mooney, for the past seven years connected with the Lehigh Valley Railroad as Traveling Engineer and Master Mechanic, and prior to that time for twenty-four years with the Lake Shore & Michigan Southern Railroad as Locomotive and Traveling Engineer, has severed his railroad connections to take charge of the Buffalo office of the Chicago Pneumatic Tool Company. Mr. Mooney has a wide acquaintance among railroad men, and with his well-known energy, will assuredly make a success in his new position, and increase the sales of the Chicago Pneumatic Tool Company in his territory.

A brace for locomotive frames has been patented by Mr. D. A. Wightman, Superintendent of the Pittsburgh Locomotive Works. This brace is one adjunct of an engine that gives a most satisfactory return for the investment. As a frame stiffener it must perform its functions perfectly, because it fills the space between frames, and extends from the cylinder saddle to the bumper beam. It is of cast iron, ribbed for lightness, and is securely bolted at the front and two sides. It is hardly necessary to say that the object of the brace is to relieve the saddle castings of the enormous strains brought upon them when the frames are unsupported at the front. Extended use of the device has been found to prevent breakage of saddles and to bear out the claims Mr. Wightman makes for his improvement.

The Carnegie Steel Co. has verified the story to the effect that it will abandon the proposition to manufacture steel cars, inasmuch as they have contracted with the Pressed Steel Co. to supply that firm with all the shapes and plates needed. The contract with the Pressed Steel Co. will involve almost \$5,000,000 per year. The Pressed Steel Co. will have a capacity of 75 cars per day. These cars contain about 12 tons of steel. This will make a tonnage of 900 per day. With 312 working days, about 280,800 tons of steel will be consumed annually, which at a price of \$18 per ton would make \$5,050,000 per year. The Pressed Steel Co. now has contracts booked amounting to about \$8,000,000 which, together with the contracts turned over to them by the Carnegie Steel Co. will amount to an aggregate of \$10,000,000. The Pressed Steel Co. has abandoned the plan of building a steel mill.

The rehabilitation of the Baltimore and Ohio South Western Railway will begin as soon as the frost is out of the ground in the Spring. Just before the line went into the hands of Receivers Harmon and Robinson a large quantity of material was purchased. This will be immediately delivered and used to the best advantage. Forty thousand tons of 85 pound steel rail have been purchased, and enough will be on hand on March 1 to enable the receivers to begin laying it at five different points on the line. Each mile of track will be carefully rebalasted and placed in first class condition. It will take 101,000 pairs of continuous rail joints for the forty thousand tons of rail. The two thousand standard box cars and five hundred steel coal cars recently ordered will be delivered in March. Additional motive power, in the shape of forty compound freight engines, weighing 156,000 pounds, and five ten wheel compound passenger engines, weighing 135,000 pounds, is now being built by the Baldwin Locomotive Works. It is expected that by the time the property is reorganized and becomes the southwestern division of the Baltimore and Ohio Railroad it will be in a physical condition fully equal to the Baltimore and Ohio Railroad.

The remarkable progress made by tools operated with compressed air is well shown by the immense calls made for the product of the Chicago Pneumatic Tool Company. Complete plants have now been supplied to the following countries: England, Belgium, France, Germany, Holland, Italy, Sweden, Russia, Egypt, Australia, India, Japan and South America, and the universal use of these tools in this country is to be added to the above. At a trial of the Boyer tools at Glasgow recently before a number of shipbuilders the results were of such a favorable character that all the ship yards on the Clyde are now said to be equipped with them. The economical use of air in the rotary devices constitutes one of their strongest points, and is chiefly responsible for their rapid introduction whenever given a trial, and this when coupled with the fact that the machines are constructed on mechanical principles by mechanics makes good their claim for superiority in workmanship as well as results. These tools have shown such a very marked gain in quantity of work turned out over the older methods that they displace that their use is now an actual necessity in order to meet competition in manufacturing, and explains the wide use of them in industrial works. The workmanship in these tools surprises foreigners and freedom from vibration is one of the strongest claims made for them. After taking one of the Boyer tools apart, a representative of "Engineering"—see issue of that journal, Jan. 6, 1899—said: "The examination thus made showed this work to be, all things considered, one of the best examples of mechanical engineering we have ever met with." The Clyde shipbuilders and English boiler makers and locomotive builders are surprised at the power and efficiency of these tools, especially the hammers, riveters, drills and chain holsts.

BOOKS AND PAMPHLETS.

The Locomotive Up to Date. By Chas. McShane; 711 pages. Illustrated. Published by Griffin & Winters, New York Life Building, Chicago, Ill. Price, \$2.50.

This book is by the author of "1,000 Pointers for Machinists and Engineers," and in many respects the style of the former work has been followed in the present one. Both books are written with a view of meeting the requirements of engineers

and machinists, and in the one before us a large amount of information concerning locomotives and their details is given. The treatment of slide valves, valve setting and the compound locomotive are most complete, while a great deal of attention is given to breakdowns, running repairs, combustion and machine shop methods. All of the important parts of the locomotive are considered and a great many devices that have been reported to be giving satisfaction are described and illustrated, nearly all of these, however, have appeared in the technical periodicals, but this does not take from the value of the book because of the convenience in having them collected and indexed. For example, here are more than twenty locomotive valves, each illustrated and described. We are glad to have this record, even of some valves that are not in general use and this feature of the book will be valuable to those who contemplate taking out patents for improvements in locomotives. They may save themselves trouble by consulting this book. The work is written in a plain style, well adapted to those who will consult it. The compound locomotives of all the prominent American types are fully illustrated and descriptions of each have been prepared by the builders themselves. Chapters on special subjects are from authorities on those subjects, as, for instance, the one on water impurities by Mr. F. W. Hornish, the inventor of the Hornish boiler cleaner, and on air brakes by Mr. Clinton B. Conger. The engravings and press work are fair.

Electric Railroad List of the World. Published Quarterly by the "Railroad Gazette," 32 Park Place, New York, January, 1899. Volume 1, No. 1.

According to the editor's announcement, this publication is designed to furnish quarterly a list of the companies operating the electric, cable and horse railroads throughout the world, together with the names and addresses of the more important officers. In short, it does the same for street railways that is done by the well-known "Pocket List of Railroad Officials" for the steam roads, and for convenience the size and general arrangement of the steam railroad list have been followed. The information has been obtained from official sources, and is believed to be reliable, as far as this is possible in the initial publication on such a complicated subject. The foreign list is naturally not complete, but omissions in the first issue are expected under the circumstances. This list will be invaluable to those who have occasion to use the names and addresses of these officials, and, as a matter of convenience, information is given covering the mileage, character of motive power and equipment of each road. As the list will be used most by those who have to do with supplies, the officials in charge of the purchasing department are plainly indicated for each road. In addition to the railway list, this publication gives the bibliography of the subject of data concerning street railways, an alphabetical list of advertisements, a list of representatives of supply companies, one of the associations of officers, an alphabetical finding list of officers of all the roads included in the book, proposed standard operating rules and proposed standard classification of accounts. The letterpress is good and the book is attractive and convenient.

Association of Railway Superintendents of Bridges and Buildings, Eighth Annual Convention, October, 1898.

This pamphlet has been received from Mr. S. F. Patterson, Secretary of the Association, and copies may be obtained by addressing him at Concord, N. H. It contains the usual records of the proceedings of the association, and also a very valuable series of tables of the strengths and deflections of wooden beams and columns, showing the safe loads and deflections which are based upon recommendations of a committee of the association appointed in 1895 to report on the subject. The tables are the work of Mr. Edgar Kidwell and Mr. C. F. Moore.

American Society of Mechanical Engineers. List of Officers, Members and Rules. Jan. 1, 1899.

This society issues two semi-annual catalogues or lists, one standard size (6 by 9 inches) and the other vest pocket size (2½ by 5 inches). We have received a copy of the former, which is an improvement upon all society catalogues that we have seen, in that the entire membership is given in a single list, with the grade of each member indicated. It has also a territorial list, but in other respects does not differ from previous catalogues of the society. The new vest pocket list will be specially valuable to members traveling, because it will include a geographical arrangement of the names.

Report of the Surgeon-General, U. S. Navy, Chief of Bureau of Medicine and Surgery to the Secretary of the Navy, 1898. Government Printing Office.

Catalogue and Price Lists of Brown & Sharpe Manufacturing Co., Providence, R. I., 1899.

The catalogues of this celebrated firm are always sought after not only by those who desire information concerning the product

described, but by those who find the information in machinery lines valuable in their business. The volume before us contains 45 pages, and besides presenting the well-known products of the works that are too well known to require comment, includes a number of new features or additions, enumerated as follows: Angular cutters with side ground concave, automatic gear cutting machines, automatic threading machines, corner rounding cutters double angle cutters, face milling cutters with inserted teeth and with threaded holes, improved stocking cutters, index wheels and worms, internal gear cutting attachments for automatic gear cutting machines, interlocking side milling cutters, metric involute gear cutters, milling cutters, milling cutters with nicked teeth, plain grinding machines Nos. 11 and 16, plain milling machines, No. 3 with screw feed; shell end mills, straight and spiral and arbors for same, spiral end mills, universal milling machine No. 1½. The catalogue will be sent upon application to any address without charge, and it is a good one to have on the desk.

Acme Machinery Company's Catalogue.—One of the neatest, most comprehensive and useful catalogues coming to us this year is that of the Acme Machinery Company, Cleveland, Ohio. The first feature to commend it is the standard size, 6x9 inches; the next to attract attention is the wood cuts and half tone engravings, illustrating their products, and last and most important of all, the excellent press work. This catalogue will repay consultation by anybody interested in bolt cutters and nut tappers, or bolt heading and forging machines, for the reason that it gives concisely the information the inquirer wants. The lead screw attachment for accurate or coarse pitch screws is illustrated and its purposes explained, and some good advice on making and recutting dies is formulated with cuts to illustrate the text. There are also some useful tables specially valuable to the bolt maker, such as the amount of stock required to make square and hexagon bolt heads; the Acme standard upsets showing length and diameter of upset for stock from ½ to 3 inches diameter; diameters, areas, weight per lineal inch and per lineal foot of round iron; number of boiler rivets to 100 pounds, etc. This latter information is prepared in pocket form, which will be sent free to any one asking for it. This company no longer publishes a list of users of their machines, as a proper presentation of their output requires all the available space in their catalogue, which now comprises 116 pages. The guarantee made in a few lines is thought to be of greater significance than a reference to the long list of patrons.

The "Book of the Royal Blue" for February, published by the Baltimore & Ohio Railroad, contains a very instructive article on "The Regular Army of the United States," by Major H. O. Helstand, Assistant Adjutant General. Major Helstand gives facts and figures concerning the military department since its organization, during the War of the Revolution. Some of his statistics are very interesting. During the Revolution the number of individuals actually in military service did not exceed 250,000; in the war of 1812 there were 471,622, of which 62,674 were regulars; in the war with Mexico there were 116,321, of which 42,545 were regulars; in the War of the Rebellion there were 2,259,168 United States troops, of whom 178,975 were colored and 67,000 regulars, the total being 2,326,168; in the war with Spain there were 219,035 volunteers (10,189 being colored) and 55,682 regulars, a total of 274,717. Major Helstand also gives the number killed, wounded and lost, and the deaths from disease in each war, including the Indian wars, and other important facts.

The Ingersoll-Sergeant Drill Company have issued a new catalogue numbered 41, showing their product in every conceivable application to land and submarine work. It is illustrated by means of clean cut half-tone engravings, which are reproduced from actual practice, in which these machines have played so prominent a part. The automatic feed and variable stroke features are fully explained for the benefit of those interested in the mechanics of the machines. The paper and presswork of the 104 pages is of the best. A comprehensive and well arranged index, and its standard size of 6 x 9 inches will make this work a valuable addition to any catalogue file. The address of the Ingersoll-Sergeant Co. is 26 Cortlandt street, New York.

We have just received a handsome colored poster from J. A. Fay & Company, the well known manufacturers of wood working machinery, of Cincinnati, Ohio. This poster is printed in red and green on fine white paper, it is about 25 x 38 inches in size, and shows in perspective over 100 of their latest designed wood working tools, the product of a special corps of experts in this line, whose only instructions are to make these tools the best of their kind. They will send one of these posters free to any one interested in wood working machinery.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

APRIL, 1899.

Table of Contents will be found on page 122.

THE LOCOMOTIVE "CENTIPEDE."


By M. N. Forney.

The following description of a "monster locomotive" is from an old paper, of which the date was not obtainable, but in all probability it was about the year 1855.

"A Monster Locomotive—A locomotive engine for the Baltimore and Ohio Railroad has just been constructed in Baltimore, which is said to be the largest in the United States or in the world. Its size and peculiarities of construction are as follows: It has 12 wheels 44 inches in diameter, 22 inch stroke, 11 feet fire box, and weighs 33 tons. This engine has been built as an experimental one, to test the practicability of drawing a train of six passenger cars up the heavy grades on the road (of which some are 117 feet to the mile) at the rate of 25 miles per hour. This engine presents a singular appearance from those now in use; one striking feature is that the engineer stands in front."

This description undoubtedly refers to a locomotive designed by Mr. Thomas Winans, which was built in the shops of his father, Ross Winans, in Baltimore, and was called the "Centipede." At that time the writer was employed there, and remembers the engine very distinctly, as it was a novelty, and interested all of us chaps who were then young.

The drawings of the locomotive were made by Mr. Frederick B. Miles, now of the firm of Bement, Miles & Co., of Philadelphia. The general design was similar to that of the Camel engines, then built in the Winans shops. They had four pairs of driving-wheels, all located between the fire-box and smoke-box. The fire-box was of the form so long used by Winans, and had a flat top, which sloped downward and backward from the barrel of the boiler, and was stayed to the crown-sheet by stay-bolts. The grate, as stated in the above description, was about 11 feet long, and the outside of the fire-box was made of as great a width as it was possible to get between the wheels. Besides this it had a combustion chamber in front. This form of engine was lengthened out in front sufficiently to get a four-wheeled truck under the smoke-box, the wheels of which were spread 66 inches. The weight of the overhanging fire-box behind was partially balanced by placing the cab in front over a foot-board ahead of the smoke-box. The fireman occupied a platform on the tender in firing.

Besides the location of the cab, there were a number of other peculiarities in the design and construction of this machine. It had what was probably the first example of a lateral motion truck used under a locomotive. The smoke-box was of the old-fashioned rectangular form, made of plate iron. Below its bottom plate was a casting with an elongated cup-shaped cavity, which was underneath. The truck itself had a similar casting with the cup on top. A cast-iron roller was placed in the cavity thus formed, between the two castings, a section of which arrangement was somewhat like this:  As the smoke-box was not confined on the truck laterally, excepting by the roller and cups, it is plain that it could move sideways on a curve, and that when it did so, the roller would roll up the inclined surfaces, and would therefore have a tendency to resume its central position on a straight line.

Another peculiarity in the truck was that the journal bearings extended the whole length of the axles between the hubs of the wheels. Wrought-iron plates were bent into the form of an inverted letter Ω , and were placed astride of the axles. A number of brass-bearings were placed on top of the axles, between them and the Ω shaped plates, and as stated, occupied the whole length of the axles between the hubs. On the lower portion of the Ω shaped plates, flanges were turned outward.

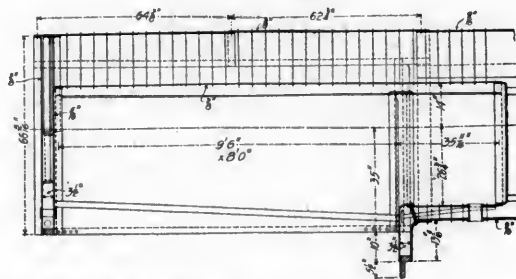
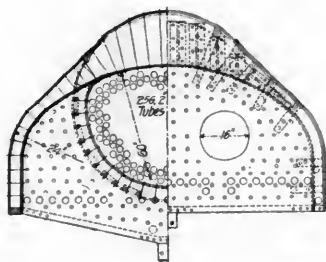
To these the springs were bolted. They were of somewhat greater length than the distances between the centers of the wheels, so that they could be bolted to each of the flanges on the lower edges of the plates. There were six or eight of these springs which formed the truck frame, and the center plate, containing the cup-shaped cavity, was attached to the top of these springs. Hook-head bolts were arranged so as to prevent the top casting from raising more than a limited distance above the lower one.

The valve-gear consisted of double valves on each cylinder. The lower or main valve was worked by two eccentrics, whose rods were attached and detached from the rockers by old-fashioned hooks. The cut-off valve was worked by a link. These valves were very large, and considerable difficulty was encountered from their cutting, and some kind of a balancing arrangement was applied to them after the engine had been running a short time.

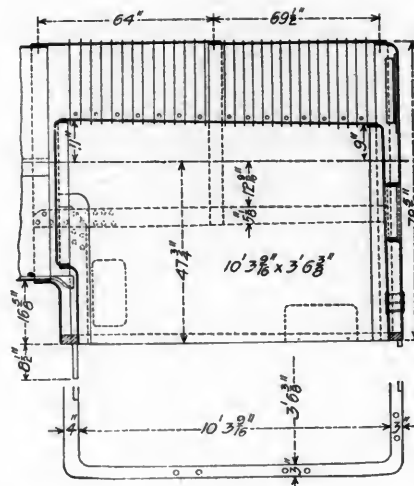
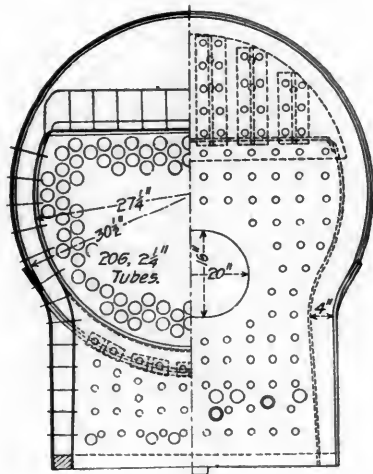
Short stroke pumps were used, which were driven by a link, so that the stroke of the pump could be adjusted. The pumps were located between the frames and below the boiler. The upper ends of the links were pivotally connected to brackets riveted to the boiler, and an eccentric rod was connected to the lower end of each of them. A sliding block was arranged in the link in the usual way. Radius rods were connected to the blocks, and to the pump plungers. When the blocks were at the lower ends of the links the full throw, or somewhat more, than that of the eccentrics was imparted to the plungers. When the block was raised to the top of the links the throw was reduced to nothing. This arrangement always seemed to the writer to be a very good one, as it permitted the amount of feed to be adjusted to the consumption of water by the boiler, which is impossible with a pump having an unvarying stroke or with an injector.

This engine was placed on the Baltimore & Ohio Railroad, and was run experimentally for some time between Baltimore and Washington, and the writer remembers going from Baltimore to Washington and back several times on this machine. It was finally laid up in Winans shop, but during the Civil War he had a number of completed camel locomotives, which the Baltimore & Ohio Company needed very badly. They made an offer for the engines, to which Winans responded that they could have them at a price agreed upon, if they would take the "Centipede" with the others at the same price, which they were compelled to do. It was then sent up to Piedmont and was used there for some time, but finally went to the bourn, which is ultimately reached by all locomotives—the scrap heap.

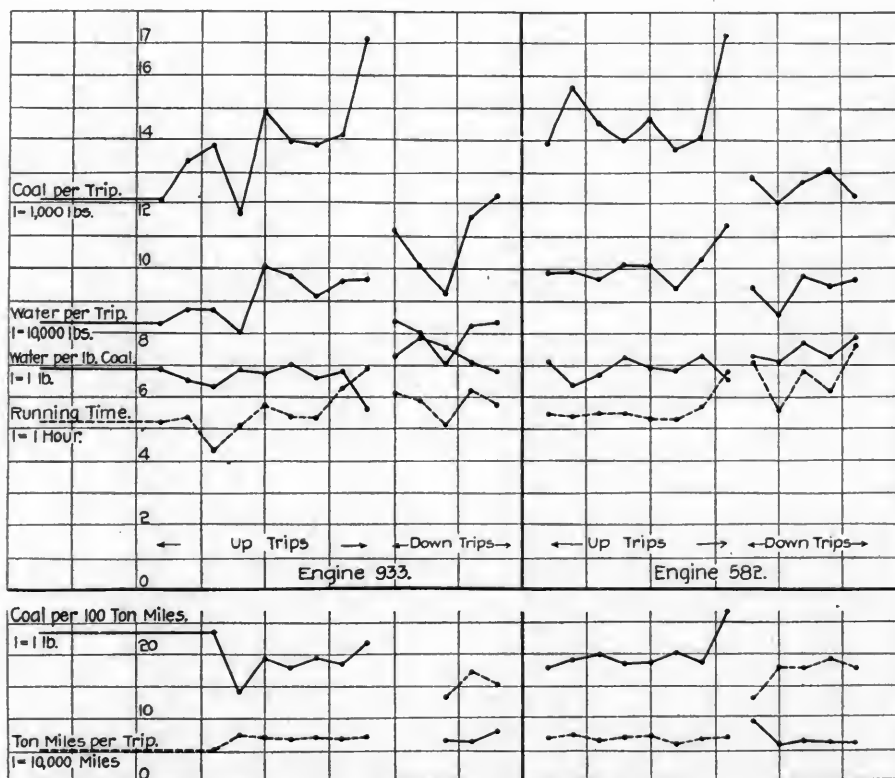
The cold weather of this winter has resulted in devising a method for thawing frozen water pipes that will revolutionize and make comparatively easy what has been a most exasperating problem. The discovery of the value of electricity as the agent for thawing was made and applied by an instructor of electrical engineering at the University of Wisconsin. Some particulars of the electric energy required are gathered from information furnished inquirers by Prof. C. K. Adams, as follows: "The source of electric power which is required in thawing pipes should be capable of producing 300 amperes of electric current, with a pressure of from 50 to 60 volts. This power may be obtained by means of an alternating current transformer connected with electric light lines or any other similar source. Whenever several pipes in a city are frozen we advise that the water works and electric light companies be asked to join in the effort to facilitate the work of thawing. Although up to the present time experience has been chiefly confined to service pipes, the method is applicable to street mains in case sufficient power is obtainable. It has been computed that 75 horse-power is required to thaw out within 30 minutes a frozen main 6 inches in diameter for a distance of 100 feet. For a longer distance corresponding power would be required. It is ordinarily found that the time needed for thawing any length of pipe less than 200 feet does not exceed half an hour after the electricity is applied."



Wide Firebox, Wootton Type, Engine No. 582.



Narrow Firebox, Engine No. 933.



Plotted Results of Tests.

TESTS ON WIDE AND NARROW FIREBOXES.—BITUMINOUS COAL.

PHILADELPHIA AND READING RAILWAY.

TESTS ON WIDE AND NARROW FIREBOXES.

Philadelphia & Reading Railway.

By H. H. Vaughn.*

It recently became necessary on the Philadelphia & Reading Railway to ascertain the relative efficiency of locomotives with the ordinary types of narrow firebox and those with fireboxes of the wide or Wootten type when burning bituminous coal. Experiments to determine the best proportion of grate that should be blocked off for economical reasons from a firebox 8 feet by 9 feet 6 inches had shown that there was a slight gain in evaporative efficiency by using the full grate area, and that in addition a larger nozzle could then be used with a diminution in the amount of sparks thrown, and this led to the belief that the wide firebox would prove as economical as the narrow for soft coal, with the advantage that it could be used for burning small anthracite if required. Through the courtesy of Mr. E. E. Davis, Assistant Superintendent of Motive Power of the road this account of the tests has been prepared for the "American Engineer."

There being no available data for locomotives with this type of firebox, a test was decided on, and for this purpose two engines were selected, identically alike with the exception that one, No. 933, was built with a straight top boiler with its firebox above the frames, and the other, No. 582, had been rebuilt from the same class with a Wootten firebox.

The leading dimensions were as follows:

	No. 933.	No. 582.
Cylinders	20 by 24 in.	20 by 24 in.
Drivers	50½ in.	50½ in.
Boiler diameter	60 in.	60 in.
Firebox	42¾ by 123¼ in.	96 by 114 in.
Heating surface, tubes	1,617 sq. ft.	1,420 sq. ft.
firebox	157 sq. ft.	199 sq. ft.
total	1,774 sq. ft.	1,619 sq. ft.
Grate area	36.3 sq. ft.	76 sq. ft.
Boiler pressure		145 lbs.
Weight on drivers	110,000 lbs.	103,000 lbs.

Both engines were fitted with rocker grates with ¾-inch spaces and ¾-inch bars in No. 933, and with ⅝-inch spacers and ¾-inch bars in No. 582. No. 933 had the Master Mechanics' Association arrangement of front end, No. 582 had a low exhaust with hopper netting, probably a slightly more efficient arrangement. The difference in heating surface is caused chiefly by the loss of tube length due to the Wootten combustion chamber, and the heavier weight of No. 933, partly on account of that firebox being stayed by crown bars, No. 582 being direct stayed. The test was continued for about six weeks, the engines running in coal service between Palo Alto and Richmond, a distance of about 94 miles, and pulling trains of about 50 loaded cars down and 60 empties up, the grade averaging about 6 feet per mile. The trains were kept as uniform in weight as possible, and in most cases were pulled through without setting out or picking up cars. The coal used throughout was known as Beech Creek; and although instructions were given at the coal docks to keep the quality uniform, no doubt it varied to a certain extent.

The fires were not brought to the same height when finishing a run as at starting because this was not strictly an evaporative test, but was made to determine the amount of coal required in service. Since the ton mile would be liable to give widely varying figures on account of delays, difference on train resistance, etc., the water evaporated was taken as the measure of the work done, but the fires were kept as low as possible on leaving the round house and brought in at the end of the run with enough coal to enable them to be cleaned, just as in regular running. The same fireman was employed throughout the entire test and every endeavor made to do this as uniformly as possible. The coal used to bank fires after cleaning is thus unaccounted for, but the extent to which this is burned would vary with the length of time in the house and would not affect the results appreciably on so long a run.

The water was measured by two gauge glasses, one on each side of the tank, placed on a line passing through the center of gravity of the surface of the water and the same tank was used for both engines. The tank was calibrated by filling it with water to a point near the top of the gauge glasses, weighing it, and draining the water off from three to six inches at a time, and taking the weight at each point. The weight per inch thus obtained can be relied on within 50 lbs. on the entire tank full of water. In running, the tank was never filled entirely since this method has been found to introduce considerable error, but water always showed in the glass so that the inches of water used could be accurately measured. Since from 20 to 30 inches were usually taken at a time and the height may be read accurately to ⅛-inch, this method is exceedingly accurate. To bring the water to rest quickly three rows of wash boards were fitted across the tank which permitted of measuring the level within a minute or so after stopping.

The weight of coal used was obtained by filling the tender on leaving the round house and taking the height of the water, cutting off the tender and weighing it on track scales. At the end of the run the tank was filled to about the same height, cut off and weighed; the allowance for the variation in the water is then small and unlikely to cause error. The track scales used were in good condition and accurate within 25 or 50 lbs. No material was allowed to be placed on the tank between the beginning and end of a run unless weighed. The water used in wetting down the coal before starting was deducted from the quantity in the tank; on the run the coal was wetted while water was being taken. This precaution is rather fine but it has the effect of preventing 200 lbs. or more water being weighed as coal. An allowance was made for the number of times the injector was used. The boiler pressure was taken every five minutes and time popping, delayed and switching, and minutes blower was used, were all noted, as much to keep the inspector busy as for any other reason. The inspector, who took all measurements, etc., was a bright young fireman, and he looked after everything connected with the test, his practical knowledge enabling him to keep all conditions as uniform as possible.

Two engineers were employed owing to the necessity for one of them to take an enforced vacation. The fifth up and fourth down trips of engine No. 933 and all the succeeding trips were made by the second man who was not by any means as good a runner as the first.

While the evaporative figures are from Palo Alto to Richmond, on account of shipping conditions, serious delays were met with between Richmond and West Falls, a distance of about six miles. The ton mile figures are therefore made from Falls to Palo Alto by noting the water used for that distance, and assuming that the coal is in the same proportion. The ton mile figures are from actual weights of car and lading. The accompanying diagram represents graphically the results of the tests showing such runs of No. 582 as were reliable and a corresponding number for No. 933. The diagram shows for each run the pounds of water and coal used, the water evaporated per pound of coal, the actual running time, including one-half the time switching, the ton miles, and the coal per 100-ton miles. These are all the figures of importance. An inspection of the diagram will show that on the whole the results are fairly uniform, and such variations as occur can be safely said to be inherent in a road test. The boiler pressure was throughout close to the maximum, the average varying from 128 to 141 for No. 933, and 132 to 141 for No. 582, both engines steaming freely. The total time on the road is not plotted but has no effect on either the evaporation or ton mile figures that is comparable to the amount of variation. Both ton mile and evaporation figures have been plotted with running time and total time on road as abscissæ without showing any relation to these factors, and the figures for coal per ton mile have been plotted with ton miles per trip as abscissæ with the same result. The variation in the figures for evaporation is probably not in ex-

* Mechanical Engineer, Q. & C. Co. Formerly Mechanical Engineer, Philadelphia & Reading Railway.

cess of what must always be expected, and simply shows the danger of basing conclusions on isolated tests. By making a large number of trips, and plotting the results the general run of the work can be judged, and the effect of extraordinary trips either good or bad allowed for. On the whole it is seen that the Wootten boiler gives slightly better figures for evaporation, but hardly enough to say that it is actually superior. It may however be safely concluded that it is certainly equal to the narrow type. On the ton mile basis No. 933 shows the lesser consumption, but this can hardly be considered as accurate a measure of the boiler efficiency as the water evaporated, since there is a possibility of the engine affecting the results.

On the whole, the test is interesting as showing at least that there is no loss in economy in using a larger grate under the conditions of this test, and there would also appear to be no reason for the economy of the wide firebox falling off if the work done once increased since the rate of combustion would then approach more closely that of the narrow firebox, while under an increased duty the latter would probably show a decrease in efficiency, due to the greater spark loss which at the rate of combustion in this test, was small. If this premise be granted, it would open an interesting question as to whether an engine with a wide firebox is not worth considering as a soft coal burner. The boiler under test, designed exclusively for anthracite, and with a height of only 40 inches from the grate to the crown sheet is, of course, too low for satisfactory results, but the center of the boiler is only 7 feet 6 inches from the rail and would thus leave room for a deeper box if desired. With the crown sheet so near the fire, not only must the combustion be interfered with, but on account of the intense heat near the door, the crown sheet seams give trouble from leaking.

A curious point about these engines when burning soft coal is the intense heat in the front end, this occurring even in engines that were steaming poorly and without any accumulation of cinders, and generally showing near the flue sheet. It could hardly be due to flame continuing through the flues, although only 10 feet 7 inches long since in that case there should have been ample steam, and occurring in engines fitted with the Master Mechanics' Association front end, and a large stack it was possibly due to combustion of the unburned gases by air admitted by the stack, an unwelcome application of the Schlicht system. Still with proper front end arrangements the wide firebox engine may be depended on never to give trouble for want of steam, with any kind of coal, and will burn fine coal in hard service without its being pulled through the flues to anything like the extent occurring in a narrow firebox engine. Free steaming is a strong point in a freight pulling machine, and while it is not an attribute of the Wootten boiler alone, it certainly is one of its strong points, and if not sufficient to recommend its use for engines burning bituminous coal exclusively, it justifies its application where there is any chance of burning anthracite.

The largest hydraulic press in the world has been recently completed at the Parkbend Forge, England. According to the "American Machinist" this machine is capable of exerting a pressure of 12,000 tons and is to be used in making armor plate. It is built of nickel steel and the cylinder is 6 feet in diameter weighing 42 tons complete. The foundation for the press is composed of 1,300 tons of bricks and a bed of concrete weighing 330 tons. The power is supplied by four sets of coupled compound condensing engines with cylinders 21 and 43 inches and 18 feet stroke. The steam pressure actuates 68 pumping rams each 11-16 inches in diameter which deliver the water to the main cylinder of the press. To lift the press face, crosshead and ram, two return cylinders are used working at a pressure of 1,300 lbs. per square inch.

66-FOOT CAR FOR STEEL RAILS.

LAKE TERMINAL RAILROAD.

The Lake Terminal Railroad, of the Lorain Steel Company, is having some long gondola cars built for the transportation of 62-foot steel rails, and we are enabled to illustrate them by the courtesy of Mr. F. H. Stark, Master Car Builder of the Cleveland, Lorain and Wheeling, who designed the cars. The cars are to carry 80,000 pounds, either with long or short material, and if the latter, the load must be equally distributed for a distance of 18 feet from each end, and instructions to that effect will be stenciled on the sides. The length over sills is 66 feet 4 inches and width over sides and sills 8 feet 11 inches, while the distance between centers of bolsters is 53 feet 8 inches, dimensions that convey the idea of immense proportions for freight service. There are eight sills of the following dimensions: Outside, 5 by 14 inches; four intermediate, 4 by 8 inches, and center sills, 4½ by 8 inches, all of Georgia pine. The end and side planks are 4 by 12 inches, and also of Georgia pine.

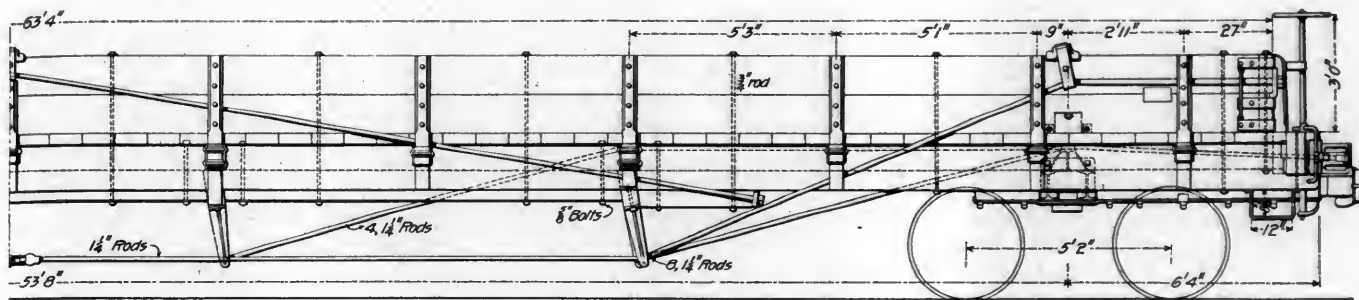
The length of the car necessitates four crosstie timbers, 5 by 12 inches, of oak, and the end sills are of the same material, 10 by 12¼ inches and faced on the outside with ¾ by 10-inch wrought iron plates, for the purpose of resisting the pull of the truss rods, of which there are eight, passing through the end sills, and two seating against the gondola sides at each side, making twelve truss rods in all to sustain the car and load between the bolsters. The truss rods are 1¼ inches in diameter with ends upset to 1¾ inches in diameter, and having special forged open turn buckles tapped for 1¾-inch ends. Since the truss rods occupy such an important place in a car of this length, every provision is made to render them as effective as possible. To this end the four outside rods are carried in a wrought iron stirrup, which in turn rests in a malleable iron saddle on top of the side planks, directly over the body bolster, the bearing having such an area as will safely distribute the crushing component of the truss rod pull, while the compression due to same cause at the side planks is taken care of by seating washers of liberal area.

Four of the longitudinal truss rods, after crossing the first pair of crosstie timbers, transmit their load to the second, or outer pair of crosstie timbers, and pass from there to the end sills. These rods take care of the load at the center of the car, while the remaining eight rods transmit the load to the bolsters. To obviate the danger of buckling at the center, due to compressive shocks, there are four counter truss rods, 1½ in diameter with 1½-inch ends, which are supported at the center of the car in a stirrup and saddle similar to that for the longitudinal rods, the ends passing down near the outer crosstie timbers, against which a block abuts, which receives the pull of the rods.

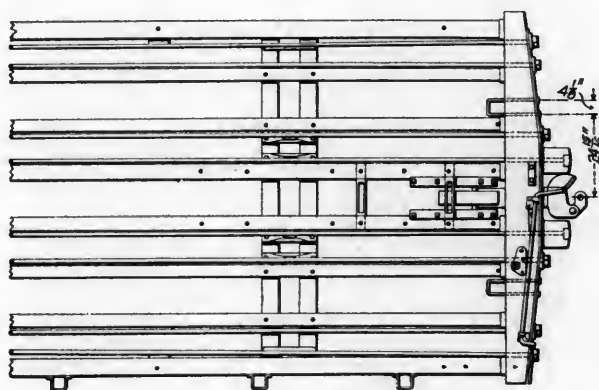
The longitudinal sills rest in malleable iron pockets, that are secured to the inner face of the end sills by ½ by 3-inch lag screws. There is a permanent floor bolster, 6 by 8 inches in section located over the body bolster, which will support the rails at the ends and allow the car to be trussed with about 4 inches of camber at the center, and then leave the load approximately level. In order that there shall be no resistance to camber from the side planks, they will be cut on the lower edge to a height of three inches at the center of the car, and running out by a true curve to the body bolsters, leaving the side planks the full depth of 12 inches from bolsters to the end of the car.

A special form of the Bettendorf I beam body bolster has been furnished for these cars by the Cloud Steel Truck Company, of Chicago.

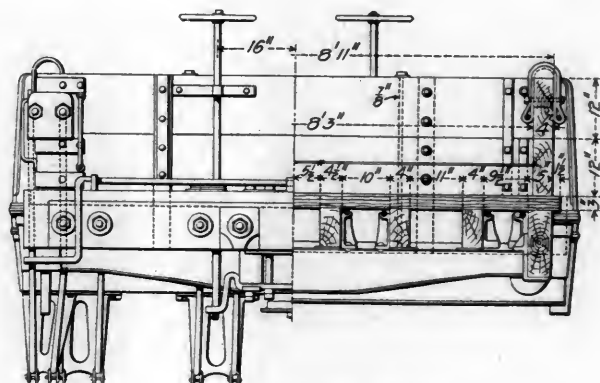
A draft gear of exceptional strength is provided for these cars. There are two double coil draft springs placed side by side between the center sills, the springs having a diameter of 1 3-16 inches for the outer coil and 11-16 inch for the inner, with a diameter over the coil of 6 inches and a length of 8



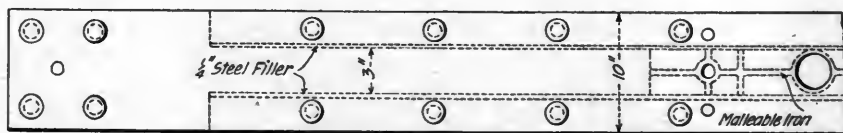
Half Side Elevation, Showing Trussing.



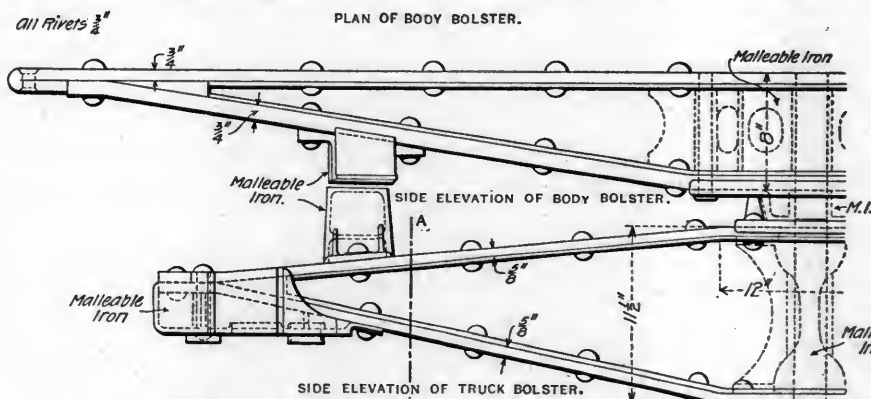
Partial Plan of Underframe.



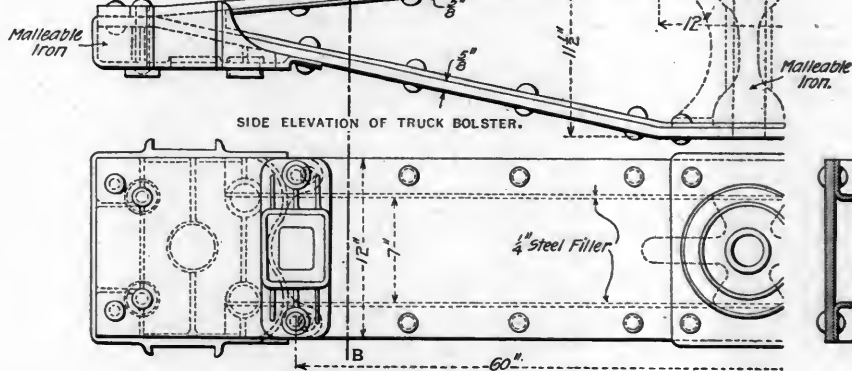
End Elevation and Section.



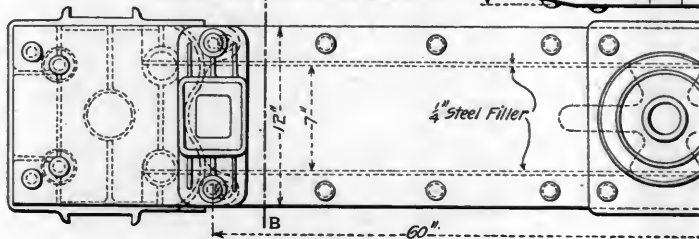
PLAN OF BODY BOLSTER.



SIDE ELEVATION OF BODY BOLSTER.



SIDE ELEVATION OF TRUCK BOLSTER.



PLAN OF TRUCK BOLSTER.

The Common Sense Bolster.

Note—This drawing shows the construction of this type of body and truck bolster. The body bolsters of the car are the "Bettendorf."

66-FOOT CAR FOR STEEL RAILS—LAKE TERMINAL R. R.

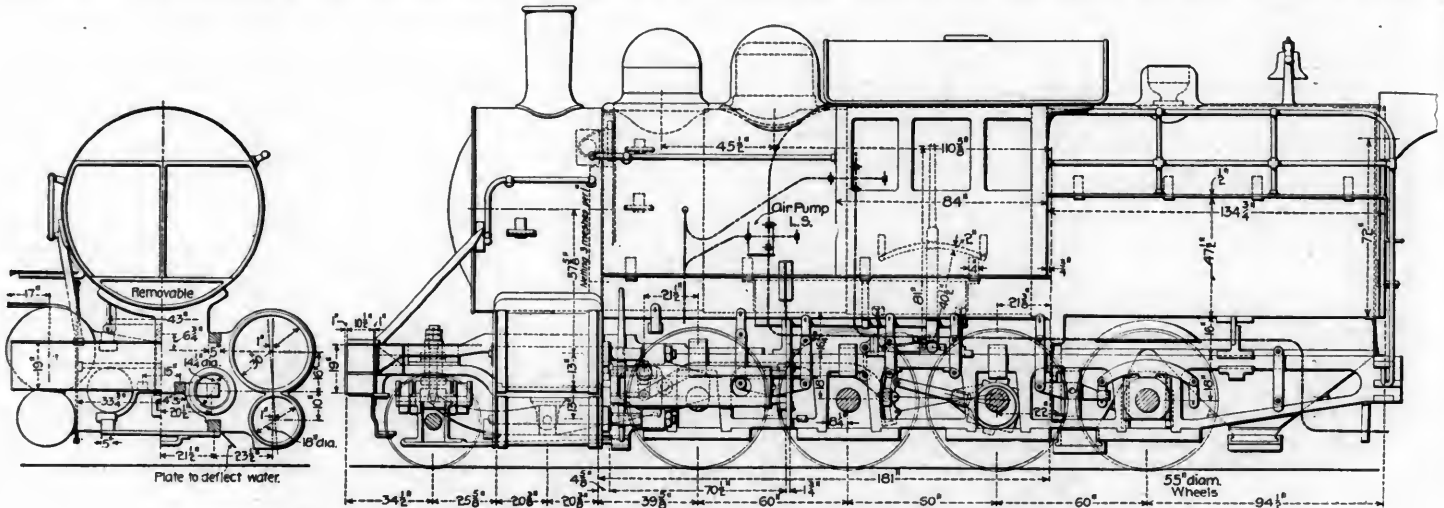
Designed by MR. F. H. STARK, Master Car Builder, Cleveland, Lorain & Wheeling R. R.

inches. This arrangement doubles the capacity of the draft springs and is a much needed improvement over the so-called standard. The $1\frac{1}{2}$ -inch followers are much stronger than if used with the single central spring. As a safeguard against undue strain on the vertical draft bolts, a $2\frac{1}{2}$ by $\frac{5}{8}$ strap is provided, with the end bent to fit into a mortise in the draft timber, while the body, $1\frac{1}{8}$ inches in diameter, is made to extend back and through the bolster with a nut and cotter on the end. A centering device, consisting of two springs of

CONSOLIDATION FREIGHT LOCOMOTIVES.

Lehigh Valley Railroad.

The general dimensions of the heavy mountain pushing locomotive recently built by the Baldwin Locomotive Works for the Lehigh Valley were given in our issue of December, 1898, page 395, and on page 11 of the January, 1899, issue the boiler and tender were illustrated. We now present an ele-



Compound Consolidation Mountain Pushing Locomotive—Lehigh Valley R. R.

[For description see "American Engineer," December, 1898, page 345, and January, 1899, page 11.]

9-32 inch bar, $1\frac{1}{4}$ -inch diameter, which are held in a malleable iron pocket on the inner face of the draft timbers, centers the drawhead and permits of a lateral movement of about $1\frac{1}{2}$ inches each side of the center. This draft gear is a substantial one and ought to give the best of service.

The truck bolster is the "Common Sense" type, with an upper and lower steel plate, $\frac{5}{8}$ by 12 inches, and a flanged filling piece riveted to both plates. The trussing depth at the center is $11\frac{1}{2}$ inches and the weight, 625 pounds, which is not an excessive weight when the capacity of the car is considered. Our illustration shows the common sense truck bolster and body bolster in order to make clear the construction of both. The body bolster, however, is not used in this car, which has the Bettendorf bolster as stated above. The truck is of the arch bar pattern, and designed for the load. Aside from these features the drawings need no explanation.

MULTIPLEX PRINTING TELEGRAPH.

A system of printing telegraphy, known as "Prof. Rowland's Multiplex," was recently tested between Philadelphia and Jersey City with highly satisfactory results. As its name implies, a message is sent and received in legible and easily read type, transmitted from keyboards similar to those of a typewriter, the characters including simply the ordinary alphabet and numerals. The device on trial was made at the Johns Hopkins University in order to demonstrate what merits it possessed and also its weakness, if any, and it is arranged for eight messages, four in each direction, and duplexed in the usual way. The messages are printed on either a tape or a page, and a speed of sixty words a minute has been obtained in some of the experiments, but the limit of speed or the number of messages was not reached. There is no other multiplex printing system sending from a keyboard and received on a page, and this one is only a part of that invented by Professor Rowland. The whole invention contemplates a relay method, by which any amount of territory may be covered, and comprises a system by which eight people in one city can be in communication with eight others in another place over one wire and with absolute secrecy. Among the advantages claimed for the multiplex system is that of less liability of error, since there is only one person engaged, and he the sender; while, by the Morse system, there is an opportunity for mistakes at each end of the line.

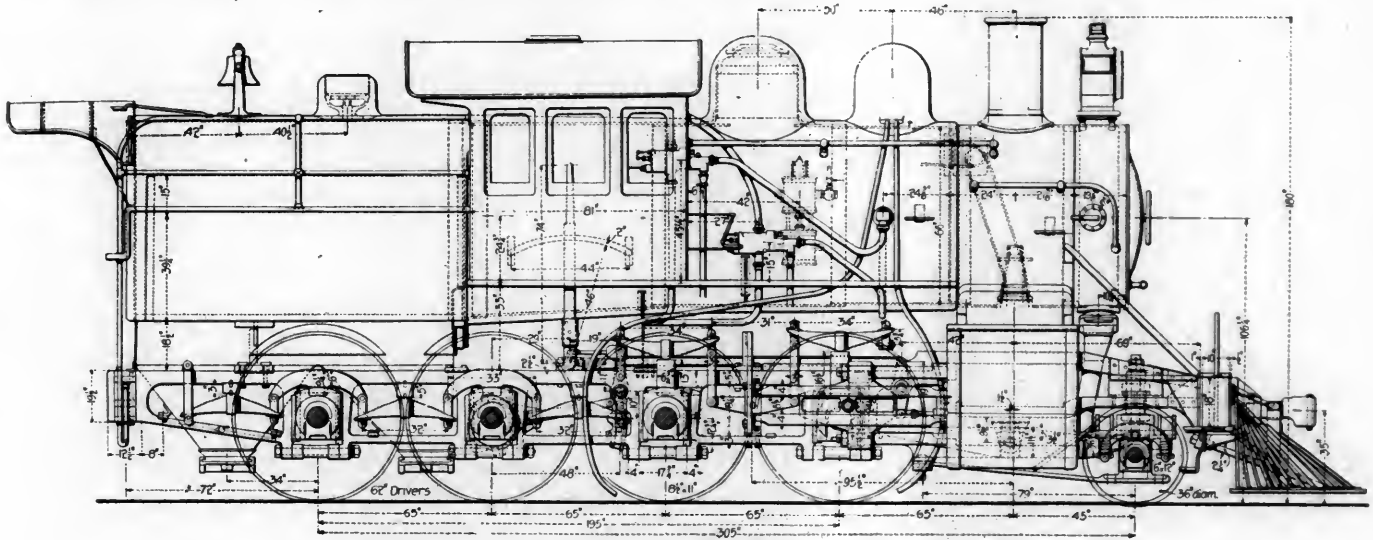
vation drawing of this engine which we believe to be the most powerful locomotive ever built, and it is next to the heaviest. The satisfactory performance of this engine has led to the ordering of nine more from the same drawings. The chief object in presenting the drawing at this time is to show the comparison between the heavy pushing engines and a new design of the consolidation type for road service on the division between Buffalo and Sayre, which is also illustrated. In the engravings the smaller engine is made to a larger scale because more details are shown, but the dimensions show the difference at once.

The lighter engines, of which two are now building at the Baldwin Locomotive Works, are intended for service on the Buffalo division, where there are some long grades. One grade is 21 feet per mile and 37 miles long, and another is 18 feet and 30 miles long. They are to pull 2,000 tons, exclusive of the weight of the engine and tender, and each is to do the work of two of the locomotives in present use in this district. One of the engines is a Vaucain compound, with cylinders 17 and 28 by 30 inches, while the other is a simple engine with 21 by 30 inch cylinders, all features except the cylinders being alike in the two designs, which were prepared by Mr. S. Higgins, Superintendent of Motive Power of the road, to whom we are indebted for the drawings. In the arrangement of the cylinders of the compound, it will be noticed that the center lines of the cylinders are not in the same vertical plane the low pressure cylinders having been drawn inward to reduce the width of the engines. The location of the reverse lever renders a reach rod unnecessary, and the drawing shows a number of interesting features, such as inverted rockers and continuous equalizing in the spring rigging throughout the length of the engine. The valve gear uses two sets of rockers, as indicated in the drawing. The driving wheels are all provided with flanges, which is not usual in the consolidation type, and especially with such a long wheel base. In fact, this is believed to be the longest wheel base for this type that has ever been used. We are informed by Mr. F. F. Gaines, Mechanical Engineer of the road, that 3-16-inch lateral motion is allowed on each side, between the driving boxes and wheel hubs, making $\frac{3}{8}$ inch in all. The main and intermediate driving

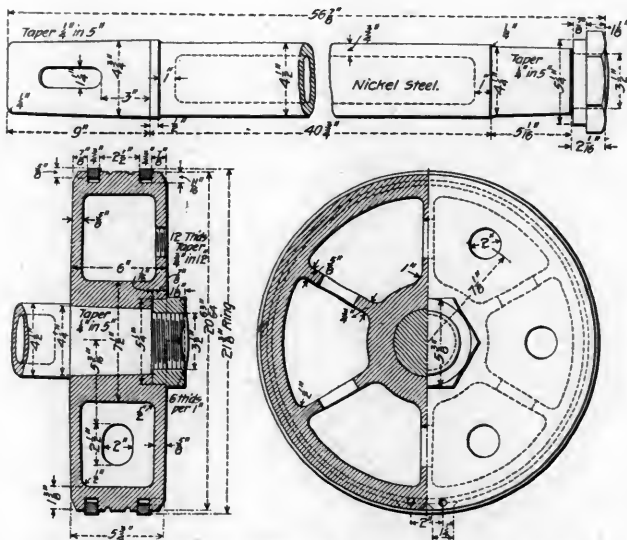
wheel tires are set at 53¼ inches, while the front and rear ones have ¼ inch less. The piston rods are of nickel steel and hollow, with a three-inch hole. The cast steel piston for the simple engine and the hollow nickel steel piston rod are illustrated. The piston is six inches thick, and very light and strong for such a large diameter.

The driving wheels of these road engines are unusually large, and will attract the attention of motive power men for the reason that small wheels have always been associated with large hauling capacity, and as that is supposed to be the prime object of building engines of the consolidation type, a

inches, while the compounds have cylinders 17 by 28 by 30 inches stroke. The simple engines will exert a starting power of 38,400 pounds, and have a co-efficient of adhesion of 0.25, while the draw-bar pull of the compounds will be 47,000 pounds, with an adhesion coefficient of 0.30. In each case there is seen to be a close approach to that ideal condition in design where utility is of first consideration, and nowhere, probably, can this be better illustrated than in the ratio of adhesive weight to tractive power as given above, which is plainly the present tendency in advanced locomotive practice.



Consolidation Compound Road Locomotive—Lehigh Valley R. R.
With 62-inch Driving Wheels.



Piston and Hollow Piston Rod—Lehigh Valley R. R.

large wheel appears incongruous at first sight. The character of the service these engines are intended for, however, furnishes good reasons for the increased wheel diameter. For heavy fast freight service they should be able to make a good record on account of reduced piston speed, while the advantage of having such an engine on the line for emergency passenger haulage in case of break down of the regular engine in that service, will be of no small moment on account of the apparent ability of these engines to haul heavy loads at high speed.

The simple engines are similar to the compounds in all respects except in cylinder proportions, which are 21 by 30

Comparing these compounds with the heavy compounds for mountain pushing service, it is seen that the adhesion coefficient of 0.298 of the latter bears a striking resemblance to that of the new road compound, the significance of which is, that both classes of engines will be able to exert their maximum tractive effort only on a dry or sanded rail, or in other words, they are cylindered up to the critical point of adhesion, and therefore carry no unavailable dead weight. A further comparison of the heavy pushers referred to above, with the Pittsburg 23 by 32 simple consolidation engine illustrated in the November, 1898, issue of the "American Engineer," shows the attention to the relation of weight on drivers to power developed at the rail, in the coefficient of 0.27, but hardly reaching the mark set by the Lehigh Valley. The tractive effort of the Pittsburg engine is 56,400 pounds, and the adhesive weight is 208,000 pounds, while the draw-bar pull of the Lehigh Valley pusher is 60,300 pounds, with 202,000 pounds of adhesive weight. The Pittsburg engine is the heaviest engine in the world, but must yield the palm of power to the lighter Lehigh engine.

Some of the leading dimensions are given as follows:

Cylinders, Compound.....	17 and 28 by 30 in.
simple.....	21 by 30 in.
Driving wheels, overties.....	62 in.
Rigid wheel base.....	16 ft. 3 in.
Total.....	25 ft. 5 in.
Height from rail to top of stack.....	15 ft.
Weight on driving wheels.....	155,000 lbs.
Total weight of engine.....	175,000 lbs.
Boiler pressure.....	200 lbs.
Boiler diameter.....	66 in.
Heating surface, firebox.....	177.7 sq. ft.
tubes.....	2809.6 sq. ft.
" " total.....	2987.3 sq. ft.
Firebox, length.....	118 in.
" " width.....	96 in.
Tubes, 358, two inch, length.....	15 ft. 1 in.
Piston rods hollow, diameter.....	4 1/4 in.
Driving journals.....	8 1/4 by 11 in.
All drivers flanged.....	
Engine truck wheels.....	36 in.
Water capacity of tender.....	4,500 gals.

LIGHT AND HEAVY CARS.

By O. H. Reynolds.

The writer has had occasion many times to notice the excessively high ratio of dead weight to paying load that is so prominent a characteristic of wooden cars, in both freight and passenger service, and has been impressed with the belief that builders of heavy cars were not serving the best interests of their employers when measuring the requirements of construction simply from the standpoint of strength, with the object of keeping the cost of maintenance at a low figure. This procedure has its analogue in the now nearly obsolete practice of allowing a locomotive to rest, with a view to prolonging its life and both are accomplished at the expense of earning capacities. The objection to a reduction of car weights on the ground of the light percentage of braking power, available when such a car is loaded, is the only one of real moment, and one that will doubtless be handled in due time in the way that all new conditions are provided for. The objection is of secondary consideration when placed against the increased capacity of the light car. There is already a strong desire for the reduction of weights of passenger trains, and there seems to be no good way to accomplish it except in the construction of the cars. The necessity for this is more forcibly brought to our attention when we consider that the load is a fluctuating one in all branches of railway service, with a possible exception in the coal and ore trade, and this serves to emphasize the contention that cars must be of light weight relative to load capacity, in order to be most productive in transportation. There are good reasons for this view, among which are the increased cost of the heavier car, and an increased fuel expense for haulage, a two-edged sword which cuts deeply into the earnings, and for which no mathematical demonstration is necessary, since it is plain that the same quantity of fuel per square foot of grate must be consumed to haul one pound of dead weight as to haul one pound of paying load, a fact of the greatest significance now that we are approaching a limit to the size of locomotives.

Freight Cars.

The loading of locomotives on a tonnage basis is largely responsible for the renewed attention to the non-paying side of the transportation question, with the result that the constantly recurring query why cars of the same nominal capacity are built so as to require different stencils for light weight, is not an easy one to answer by those that have gathered their design inspirations from the school of strength as the prime consideration. This fault is a glaring one in the wooden car, and is more in evidence perhaps in those of 40,000 pound capacity than in the later cars of greater capacity, but the fact remains that cars may be reduced in weight without impairing their usefulness as carriers, with a corresponding increase in net earnings.

Proof of this is seen in the 60,000 pound capacity box cars of the Chesapeake & Ohio, of which the light weight is only 25,000 pounds; a weight actually less than in average 40,000 pound cars. This was a 34-foot sample car of which Mechanical Engineer Hoopes, of the office of Mr. W. S. Morris, Superintendent of Motive Power, says in a letter:

"This car was built to see how light a car could be made, to carry a load of thirty tons. It is fitted with air brakes and M. C. B. couplers, was built about five years ago and placed in freight service. This car has been shopped several times for examination, and has always been found in good condition, requiring no repairs. We have another class of cars, of which we have 100, which we built with a view to having the car as light as possible. This is a stock car with feeding and watering arrangements. The car is 36 feet long inside and of 30 tons capacity, weighing 27,300 pounds. The sizes of sills are: Outside, 4x8 inches; intermediate, 3½x8 inches, and center, 4x8 inches. This car has eight sills. The posts and braces

being made as light as consistent with the required strength. The flooring, side slats, etc., are grooved. This manner of making the flooring we find to be a great benefit to the car aside from reducing the weight, as it allows a circulation of air between the tops of the sills and the flooring, and it causes the moisture to dry out much sooner than it would otherwise. We believe that there is entirely too much timber put in most freight cars, and not enough attention given to the truss rods. This latter car has four rods, with a truss 20 inches deep below the sills. All castings of the car body and truck are of malleable iron. The feeding and watering troughs are of pressed steel. These cars were built about four years ago, and have proved to be good substantial cars of their kind, not having sagged or given way at any part of the framing. They weigh between 5,000 and 6,000 pounds less than most cars of the type, size and capacity, and are just as serviceable."

This is a practical application of Mr. Morris' policy of increasing net earnings by hauling a pound of paying freight for every pound of reduction in weight of car, and this was done before the tonnage question had become a live issue. The framing of Mr. Morris' stock car is shown in Fig. 1. It is also very light.

A reference was just made to malleable iron castings as one of the factors in reducing weight, and they always play an important part in the scheme of lowering the light weight of cars. The value of malleable iron in this special field is well told by Mr. Eugene Chamberlain, in his paper on "Malleable Iron in Car Construction," read before the Central Railway Club, in which he said:

"Now as to the question of dead weights: With a reduction of from 1,300 to 1,500 pounds per car of 60,000 pounds capacity, as compared with gray iron castings, we readily see that an extra car might be easily added to each train of 15 cars without placing any additional tax upon the motive power. Or, assuming that a railroad company is deriving a revenue for carrying 20,000 pounds of gray iron castings, could not this revenue in all fairness be credited to the original cast of malleable iron castings as the producing cause? This does not occur once a year or once a month only, but is in evidence every trip of the train, thus adding strength to the argument we seek to advance, and creating a revenue for the company from an apparently undiscovered source. If we take what statistics show it costs a railroad company per ton per mile to haul freight, and a car will average say twenty miles a day for a year, and there is a reduction in dead weight of 1,300 to 1,500 pounds per car on account of using malleable castings, a simple calculation with the foregoing figures as a basis, will readily demonstrate that the company is deriving a yearly revenue equal to one-half the original cost of the malleable castings used on the car. Add to this a reduction in the stock of castings necessary for a company to carry on account of less breakage of malleable iron as against grey iron castings, and we secure a sum total that would seem to recommend malleable iron castings for general use in car and locomotive construction and repairs."

The ratio of paying load to dead load in the case of the light wooden box car of the Chesapeake & Ohio is 2.4. This is probably as high as wooden construction will permit for box cars, but a slightly higher ratio (2.53) is found in the 80,000 pound wooden gondola cars of the Illinois Central, which is no doubt the limiting figure for wood. These cars weigh 31,500 pounds empty. Steel, however, presents means of raising the ratio of load capacity to dead weight, and we find such proportion on some 100,000 pound steel cars to be 3.8. These cars are for ore service, and are only 26 feet long, they therefore vaguely indicate what may be done in the design of the all steel box car which is yet to come. There are, however, sufficient data to be gathered from the steel cars already built to show the advantages of that construction, in reducing the number of cars to the train, and therefore the resistance on curves, as well as increasing the tonnage per car, all of which results

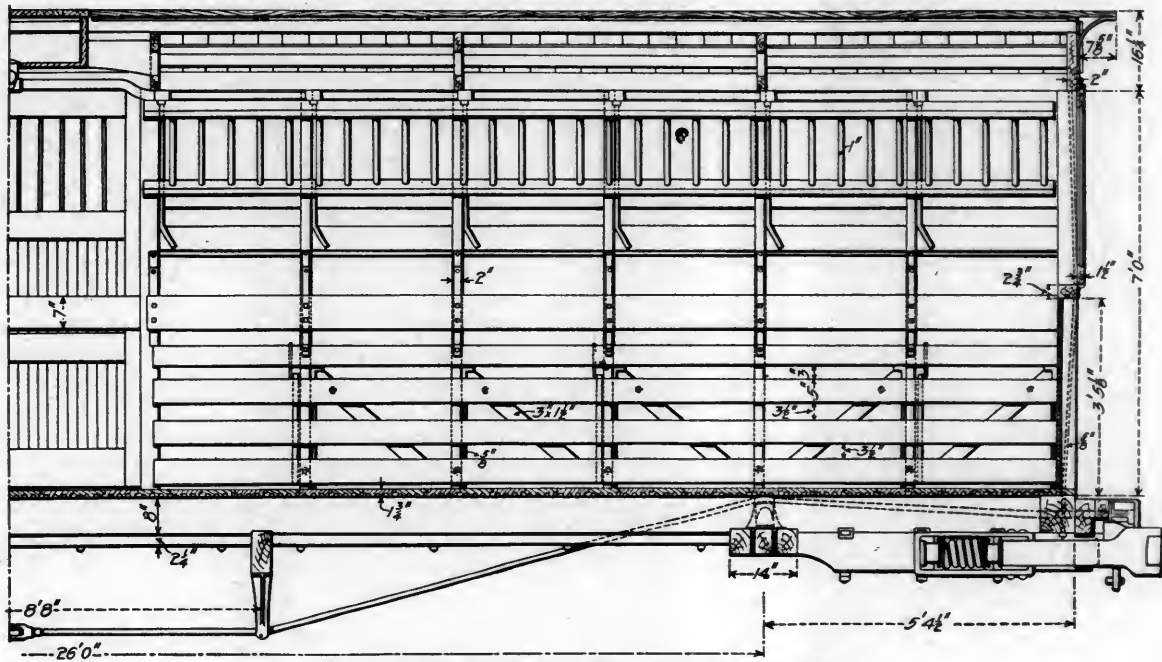


Fig. 1.—Light Stock Car—Chesapeake & Ohio Ry.

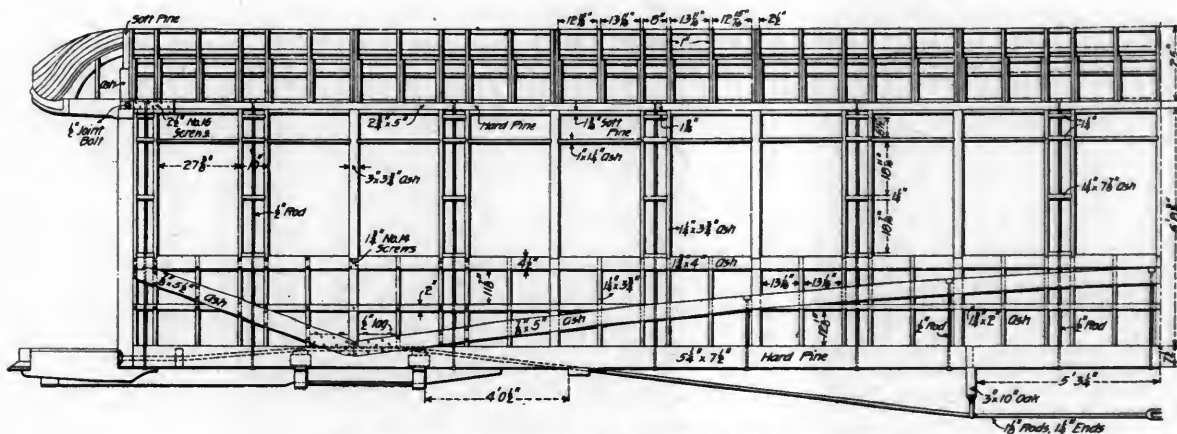


Fig. 2.—Light Passenger Car—Boston & Albany R. R.

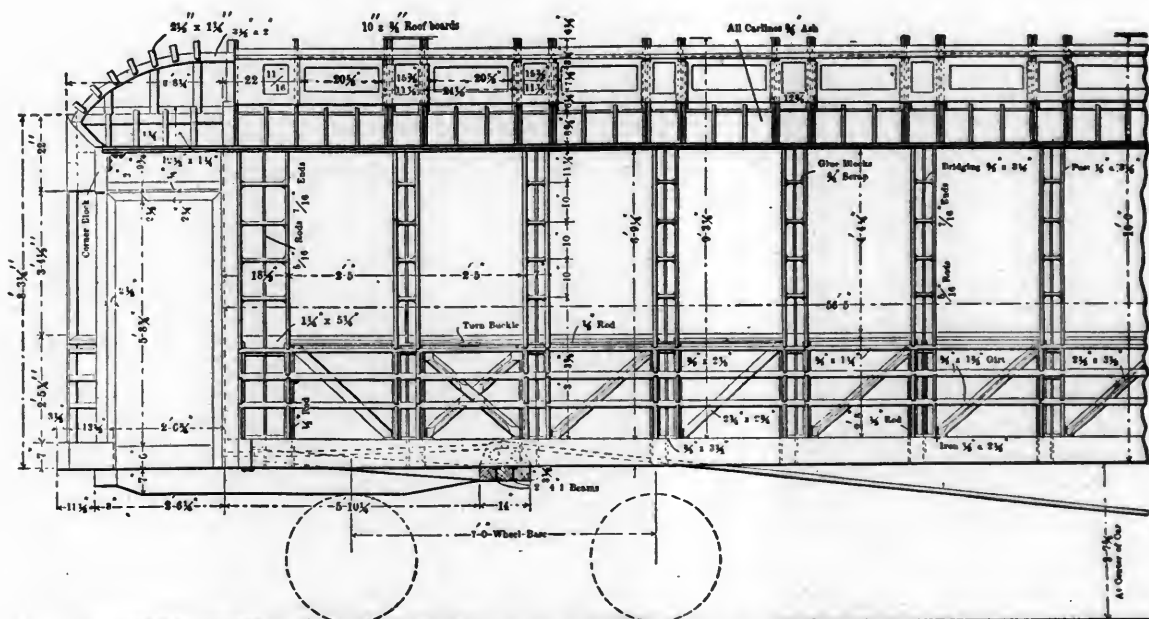


Fig. 3.—Light Passenger Car—N. Y., N. H. & H. R. R.

are desirable to attain when considering economy in transportation. That these advantages are not chimerical is now well known, that they are not obtained at a prohibitive cost may be seen by a comparison of the cost per ton of capacity for the wooden 60,000 pound car and the steel 100,000 pound car. The cost of the former will be not far from \$500, and of the latter about \$800. Assuming these prices to be correct, the cost per ton of capacity will be practically \$16 for each car, and here is to be found the reason for the recent large orders for large capacity steel cars.

The interest awakened in the large car in this country has led to some investigation of its status if pitted against foreign cars in the same service, which resulted in a comparison of two coal trains—one English and one American, by Vice-President Joseph Price, of the Grand Trunk. The English train was made up of 57 coal cars, having a total weight of 852 tons, and the American train had 24 gondolas, the loaded weight of which was 919 tons. The paying load per cent of the English train was 51.71, and of the American, 61.11. The English train had 130 axles and the American 109. This comparison shows the large capacity of the American cars to be advantageous, but occasion was taken to explain that the conditions in England were such as preclude the possibility of following American practice, owing to certain restrictions in tunnel dimensions and turntables.

Passenger Cars.

It is worthy of comment, that while there is such a well defined recognition at this time of the necessity of a high percentage of capacity to light weight in a freight car, the proportion of weight hauled per unit of paying load in a passenger car is neglected, as the rivalry of competing lines is a constant incentive to furnish better and roomier accommodations, with retiring rooms, vestibules and other luxuries unknown in the older equipment. Some first-class coaches of to-day will average 65,000 pounds in weight, and seat 60 people, which means a dead weight of 1,000 pounds to be hauled for each passenger when the car is filled. The coach of only a few years ago weighed 38,000 pounds and seated the same number of passengers as above, with 630 pounds of car per passenger. The initial cost of these later cars also helps to swell the loss side of the account, for they cost from \$6,000 to \$8,000 as against \$3,500 to \$4,500 for the car with the fewer palatial b'ds for patronage.

The acme of extravagance is reserved, however, for the sleeping car service, where the gap between first cost and seating capacity widens to an unbusinesslike degree. The cost for the least magnificent of these is from \$15,000 to \$20,000, and runs into a higher figure for the more pretentious creations. The average weight of these cars is about 95,000 pounds, and the seating capacity is 24 people for a twelve section car. The load necessary to carry one passenger is about 4,000 pounds in this case, but a worse situation presents itself when it is stated that some of these cars are seldom loaded to their full capacity.

In direct harmony with these heavy American cars is the English sleeping car with a seating capacity of 16 passengers and a weight of 50,000 pounds, which gives a ratio of dead weight to passenger a little lower than that of our sleeping car, the cost, however, is quite different, averaging \$6,000 to \$7,000, or the price of our first-class coach. These figures it must be understood refer to the English design of sleeper, and not to the American, which is in service on some foreign lines. The English composite car, carrying first, second and third-class passengers, of which we have no counterpart in this country, weighs about 42,000 pounds, and seats 33 people. The cost of this car is \$4,000; the dead weight per passenger is 1,200 pounds, somewhat more than ours, for a service no better than is furnished by our best modern coaches.

Since about 1870 the weight of passenger cars has steadily increased, while the seating capacity has to an appreciable extent become less rather than greater, against the protests of

the officers responsible for their design. Vestibules and end corridors, the latter separated by bulkheads from the seating room of the coach, together with heavier framing, all contributed to greater weight without any returns in capacity. A letter from Mr. F. D. Adams, the veteran Master Car Builder of the Boston & Albany, on this subject of passenger car construction, contains some interesting points. Mr. Adams writes:

"I used to feel much interested in this matter (light construction), as I believe that railway companies haul much more dead weight in their passenger equipment than is necessary to the passengers carried. The tendency of late years has been to have in mind the strengthening of cars, and to do this large amounts of iron and heavier timbers have been used instead of trying to get strength with least weight. One car in particular was built at Allston shops about twenty years ago, and is now in service, in good condition. It weighed when placed in service, only 36,000 pounds, and seated 76 passengers. This car has been in continuous service ever since, and looks in as good shape as cars that weigh 20,000 pounds more. The material was cut down everywhere possible. The sills were 4x7 inches; the window posts only $\frac{7}{8}$ x3 $\frac{1}{4}$ inches; floor was double $\frac{7}{8}$ -inch thick, and lining under; roof boards were $\frac{5}{8}$ inch thick; paneling outside and inside only $\frac{3}{8}$ inch thick, but was thoroughly glued with strong glue with canvas all over inside; carlins $\frac{7}{8}$ inch thick strengthened with iron every 6 feet. The furring between window posts was cross-braced, locked together and only $\frac{3}{8}$ inch thick, but all was carefully fitted and glued, the workmanship carefully done, and the result shows for itself. This car has done as much service as any other, being run in regular trains without favor, and is still good for many years yet. I supported my cars differently from any one else, by using an arch under the window rail, stepped into the sill on each side or rather both sides of the window posts, with rods from the arch down through the sill, and putting a saddle at top of the arch for the rod to pass through between them. The outside one was carefully fitted into the post and glued and screwed. The arches were $\frac{7}{8}$ x5 inches, and the inside one glued and screwed to the post also, and the inside lining was fitted snug to it. This arch took the place of the heavy truss plank usually used, and did not weigh more than one-eighth as much, while sustaining more weight. There is one thing I will admit in connection with light cars, they cannot be made to ride as easy as heavier cars."

This is a valuable contribution to the literature of light cars from an eminent authority, and it carries an important moral in the fact that passenger coaches may be built with a dead weight of 470 pounds per passenger, and still stand up under the ravages of 20 years' service.

Through the courtesy of Mr. Thomas B. Purves, Jr., Superintendent of Rolling Stock of the Boston & Albany, we illustrate in Fig. 2 the framing of their standard coach. Referring to the light car built by Mr. Adams, and his present standard, Mr. Purves says: "Coach 44 (the car described by Mr. Adams) was built in 1897, and is the lightest car we have. The weight of the body of the car is 23,970 pounds, and trucks 12,020 pounds; making a total weight of 35,990 pounds. This car has a seating capacity of 76 passengers. I regret very much that we have no blue prints or drawings of this car. I send you blue prints of our standard passenger car; the weight of body of this car is 34,100 pounds, and weight of trucks 19,380 pounds, a total weight of 53,480 pounds."

This car has a seating capacity of 78 passengers, which means the respectable ratio of 685 pounds of car to one passenger, and while somewhat heavier than car No. 44, it makes a showing decidedly favorable to its designers at a period when the tendency is to increase weight. The framing carries its own lesson without comment.

A strictly modern car embracing every known expedient to reduce weight, and at the same time retain all of the outward

points of the standard car of the road, is seen in Fig. 3, which illustrates the framing of the light car built by the New York, New Haven & Hartford. It shows one of the latest revivals of interest in light cars, and without doubt exemplifies very nearly the limit at which framing can be cut in dimensions with our present construction. This car is 56 feet 5 inches long and 9 feet 6 inches wide over sills. It has vestibules and is fitted with all equipments familiar to the best practice, but weighs only 51,750 pounds, which is nearly 8,000 pounds less than the other cars of the same size on the road, and gives 690 pounds of car per passenger. Attention is directed to the details of this car; they will be found interesting enough to dwell upon. The roofing is $\frac{3}{8}$ inch thick; all carlins are $\frac{3}{4}$ inch thick; side posts are $\frac{7}{8} \times 3\frac{1}{2}$ inches; belt rail $1\frac{1}{4}$ inches thick; sheathing $\frac{3}{8}$ inch; flooring $\frac{1}{2}$ inch for lower course, and $\frac{3}{4}$ inch for upper; sills, center and outside, $4\frac{1}{4} \times 7\frac{3}{4}$ inches, two intermediate, $3 \times 7\frac{3}{4}$ inches.

The overhang is supported by a truss passing over the braces and under the belt rail, with the ends passing through the sills at each side of the body bolster, the lifting effect being produced by the turnbuckle shown. This car was built in the fall of 1896. It was designed by Mr. E. E. Pratt, one of our veteran Master Car Builders, but who is now Superintendent of Buildings of the above road, and built by Mr. Appleyard, Master Car Builder of the N. Y., N. H. & H. at the New Haven shops. Mr. Pratt, while at the head of the New England car department, was for years an ardent advocate of light construction, and does not think that a car must necessarily be heavy in order to ride smoothly, as the following extracts from his letter referring to the light car of the New Haven road will show; in this connection he writes:

"This car is running now in the five-hour trains between New York and Boston, via the Air Line Route, and has been in that service ever since it was built. As that is one of the most important trains and largely patronized, it would seem that it has given entire satisfaction or it would not have been kept in that service. I believe that it is feasible to have light weight cars, and that they can be made as comfortable riding as any car in existence. The car can be lightened up a good deal, as the effort in that case was entirely confined to the body of the car. Twelve years ago I built a light weight car and constructed the trucks on the light principle. The trucks when complete weighed 16,000 pounds, while the trucks under this car (the New Haven) were of the standard pattern of trucks, which we put under the parlor cars of this road, and weigh something like 21,000 pounds. The 16,000 pound trucks have now been in service twelve years, and are still in fine condition, while the repairs on them have been very light in comparison with the trucks of ordinary build."

The Manhattan Elevated cars of about 1880 furnish another example of light construction that must not be passed unnoticed. These cars were constructed for a service where light weight was of prime consideration. The length inside is 38 feet 6 inches, and the weight about 30,000 pounds, while the seating capacity is 48 passengers. The ratio of dead load to passenger is about 625 pounds for the rated capacity of the car, which is more than doubled during the rush hours.

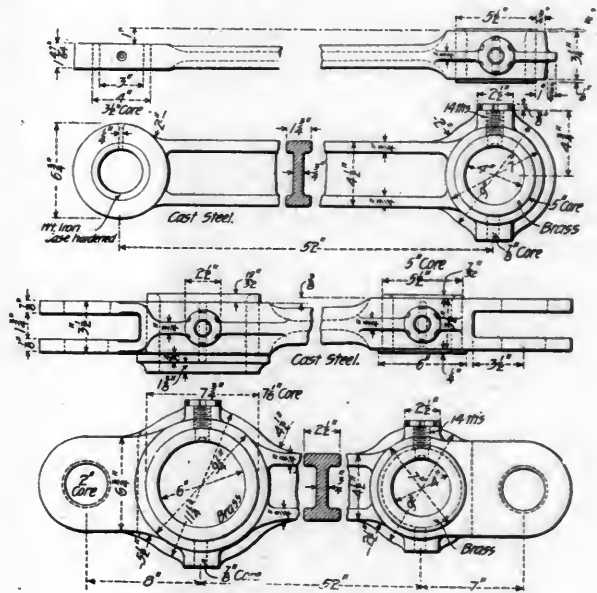
If further confirmation were necessary to show that the net revenue of railways was made to languish by the heavy car load, it will we believe, be forthcoming in the not very remote future, when the rapidly closing avenues for retrenchment in operating expenses will force a reduction of weight to a reasonable and paying ratio of load hauled.

The use of electro magnets is proposed for the recovery of a large number of steel rails which were sunk in the Ohio River. The "Electrical World" states that a crane boat will be equipped with waterproof magnets capable of lifting 4,000 pounds each. The work will be done by the Langton Electric Company, Pittsburg, Pa.

CAST STEEL SIDE RODS.

Philadelphia & Reading Railway.

The illustration of side rods herewith, represents the practice of the Philadelphia & Reading, as applied to consolidation engines, and is printed by courtesy of Mr. E. E. Davis, Assistant Superintendent of Motive Power and Rolling Equipment. Evidence of careful thought is seen in this design, particularly in the ribbing over the ends, a place where a combination of strength and lightness is required as much as in any part of the rod, for the reason that a very light section may be made here, and one that will successfully resist all piston stresses, but at the same time the bushing may get loose. The rib should prevent this action while still preserving a proper degree of lightness at the end. There are now



Cast Steel Side Rods.
Philadelphia & Reading Ry.

50 sets of these rods in service, and they are so satisfactory that all consolidation locomotives on the road are to be fitted with them.

A comparison of the cost of these with wrought iron rods for the same class of engine shows the steel rods to be somewhat higher than wrought iron by the figures furnished by Mr. Davis.

Cast Steel.

Full set of cast steel rods, finished, weight, 820 pounds.
Cost of labor, finishing rods.....\$12.30
Total cost of rods without brasses..... 80.30

Wrought Iron.

Full set of wrought iron rods, finished, 810 pounds.
Cost of labor, finishing rods.....\$19.58
Total cost of rods without brasses..... 72.31

The cost of labor for the steel is less, and the difference in the total cost is therefore to be ascribed to the present high price of the steel, which was due in part to rigid specifications. The specifications for this material called for tensile strength between 60,000 and 75,000 lbs. per square inch; and the elongation 30 per cent. for 60,000 lbs. tensile strength and 24 per cent. for 75,000 lbs.

We have no record of the tests on the heats used by the Sargent Company for the rods which they have furnished to this road, but the following table of limits represents the chemical constituents of the metal regularly produced for general steel castings:

	Per cent.		Per cent.
Silicon.....	0.30 to 0.40	Sulphur.....	0.03 to 0.04
Carbon.....	0.25 to 0.30	Phosphorus.....	0.025 to 0.035
Manganese.....	0.70 to 0.90		

The metal furnished the Philadelphia and Reading is the same as that furnished to the Chicago and Northwestern, the test record of which is as follows:

Steel Castings for the C. & N. W. Ry.

Date.	—Original.—		—After fracture.—		Tensile strength Area, per sq. in.
	Dimension.	Area.	Dimension.	Area.	
Jan. 5, 1899.....	1.0000	.7854	.740	.430	69,300
Feb. 4, 1899.....	.9850	.7620	.755	.4477	62,508
Feb. 14, 1899.....	1.0000	.7854	.710	.3959	62,906
Feb. 22, 1899.....	1.0000	.7854	.761	.4548	66,068

Elongation.		Reduction of		Elongation.		Reduction of	
In 8 in.	Per Cent.	Area %.		In 8 in.	Per Cent.	Area %.	
1.94	24.25	45.22		2.28	28.50	49.59	
2.05	25.62	42.33		2.02	25.26	42.09	

In this connection the record of seven tests on material furnished to the United States Government, the last two of which were made at St. Paul by the Government Inspector, are interesting:

Steel Castings for the United States Government.

Date.	Shoulders 3 inches.		Shoulders 2 inches.	
	Tensile Strength Per Sq. In.	Elongation Per Cent.	Tensile Strength Per Sq. In.	Elongation Per Cent.
Feb. 15, '99.....	62,750	32.	50.0	
Feb. 16, '99.....	66,500	31.	48.5	
Feb. 17, '99.....	68,900	31.	39.3	
Feb. 22, '99.....	67,650	30.	45.75	
Feb. 28, '99.....	70,000	29.	42.4	
Feb. 3, '99.....	70,250	35.	45.	
Feb. 6, '99.....	69,850	32.5	46.	

With a reduction of the price of the castings, the steel rods will be cheaper than those of iron. There appears to be no good reason why the cast steel rods should not be used when experience in casting permits of reducing the cost to that of producing other similar steel castings. This case may be considered as experimental. It is too early to express opinions as to the practice beyond a statement of the satisfaction which has led to their adoption in this case. It seems advisable, however, that caution should be exercised in the reduction of machine work on steel castings of such importance, because of the possibility of defects in the castings, which are to be found only by machining, and it is proper to raise the question whether the amount of machining may safely be reduced until such time as steel makers are more sure of their product.

At the March meeting of the Central Railroad Club a committee on car roofs, consisting of Messrs. Waitt, Macheth and Mackenzie, presented a report that reviewed everything in the semblance of a roof cover, from the single and double board to and through the various types of composite metal and wood roofs. After stating the prerequisites of a perfect roof, the committee gave it as their opinion that the best type of car roof, that is, the one most fully meeting the qualifications named, is one having a complete metal protective roof for excluding moisture, cinders and dust. This metal roof, being composed of short sheets of galvanized iron, extending from plate to ridge pole, and so applied that they can be removed without having to remove the outer roof boards. This metal to have laid over it, with an air space between, a single course of matched boards. The whole to be thoroughly secured together and to the car by bolts and long wood screws. In addition to this, it was recommended that a course of sheathing be laid on the under side of the ceiling lengthwise of the car as a protection against punctures of the metal sheets when loading and unloading freight. The cost of such sheathing would amount to not over \$8 per car and would save many times that amount in repairs and claims for damages to freight.

There are 55 war vessels contracted for or now building for the United States Navy, according to the report of Admiral Hichborn, Chief Naval Constructor. The following are the proportions completed:

Ship.	Builders.	Conditions. Per Cent.
Kearsage	Newport News	85
Kentucky	"	83
Illinois	"	62
Alabama	Cramps	76
Wisconsin	Union Iron Works	63

COMMUNICATIONS.

RAILROADS AND THE CAR COMBINATION.

Editor "American Engineer:"

I am overwhelmed with letters based on a statement that the New York "Herald" of the 14th represented this company as being dissatisfied with the Car Trust, so-called.

I desire to say that it is my point of view that the legitimate business of a railway company is transportation, and the nearer it sticks to its legitimate business the better for it.

I know of no reason why the trust cannot manufacture at as low a cost as the constituent companies have manufactured, and until there is some evidence that the trust intends to exact exorbitant profits, I can see no reason for railway companies even considering the problem of manufacturing cars. Therefore you may say that the Chicago Great Western Company has no intention whatever of entering into the business of manufacturing cars.

A. B. STICKNEY,

President Chicago Great Western Ry.

St. Paul, Minn., March 18, 1899.

THE RESISTANCE OR LAGGING OF LOCOMOTIVE VALVES

Editor American Engineer:

In the March number of the American Engineer the opinion is expressed by yourself and Mr. Henderson that the designed port openings in locomotives are not obtained, even when piston valves are used, owing to the springing of the gears.

It seems to me that if this were true to any appreciable extent, the engines would be rendered inoperative at short cut-offs. In a large proportion of locomotives not more than $\frac{1}{4}$ or $\frac{3}{8}$ inch openings are obtained in the earlier cut-offs, and a very little lost motion and springing of the valve would wipe this out altogether. Old engines with unbalanced slide valves could not be made to run under such conditions.

Now, as practice never upsets correct theory, it is evident that Mr. Henderson and yourself have overlooked a very important factor in the correct understanding of valve motions, viz., the inertia of the valve. As the deceleration of the valve is greatest during the last quarter of its stroke, during which the port opening is effected, it is evident that all elasticity and lost motion of the gear is taken up and added to the stroke of the valve, thereby increasing instead of diminishing the port openings. This is, of course, especially true of piston and balanced slide valves operated at high speeds.

W. F. CLEVELAND.

Philadelphia, March 3, 1899.

[Our correspondent would be right in his view of the effect of inertia of valves, if they were perfectly balanced, and our criticism was directed to the valves that are not perfectly balanced and to those of the piston type which are so made as to permit steam pressure to set the packing strips out against the casing. Piston valves are now in use which are so made, and are little better than balanced slide valves because of this trouble with the packing. Returning to slide valves, we would remind our correspondent of the tests on large and small valves on the Chicago & Northwestern, reported on page 356 of our issue of October, 1897; also the experience on the same road recorded in the Proceedings of the Western Railway Club, September, 1896, page 21, and April, 1897, page 377.—Editor.]

FEED WATER HEATERS FOR LOCOMOTIVES.

Editor American Engineer:

I have always believed that it would pay to try to use feed water heaters on locomotives, and I cannot see any insurmountable mechanical difficulties in the way. The idea is not at all new, and the articles on pages 20 and 27 of your January issue reminded me of a heater that the late Mr. W. S. Hudson, of the Rogers Locomotive Works, designed in 1859, and fitted to a number of engines for the Southern Railroad of Chili. It consisted of a cylinder, about 16 inches in diameter and perhaps six feet long, carried back of the cylinder saddle and

between the frames. The feed water passed through the cylinder from one end to the other, and came into contact with a number of tubes through which steam from the exhaust pipe was led and was afterward returned to the front end and directed up the stack. This heater was used for some time, and I do not know why it was abandoned, but probably because, with the comparatively small demands made on the boilers of that day, the need of feed heating was not felt, and it was difficult to measure the advantage of such devices at that time.

I agree with Mr. Francis W. Dean in the opinion he expressed in his excellent paper on boilers, read in December before the New England Railroad Club. Mr. Dean said that the great possibility of heating the feed water by the exhaust steam from the locomotive frequently occurs to engineers, and, although it is not received with much patience, it ought to be studied out to success. "It takes only about one-sixth of the steam from the exhaust to raise the temperature of the feed water from fifty degrees to two hundred degrees, and this would save about fifteen per cent. of the fuel. As the locomotives in this country use about one-third of the coal mined, or over fifty millions of tons per year, this means an enormous saving in money. I am glad to see that one of the railroad clubs has been discussing the best use of the exhaust of the air pump. This might be used for heating the feed. If the feed can be heated it will necessitate the use of pumps instead of injectors, and, moreover, pumps driven by the main engine, instead of steam pumps, for the use of the latter gives more exhaust to deal with."

A. E.

DISCIPLINE AND EDUCATION OF RAILWAY EMPLOYEES.

Editor "American Engineer:"

Thus far the discussion in your pages on the question of discipline has brought out only one adverse opinion, that signed "Master Mechanic" on page 83 of the March number, and I would like to know the opinions of some of the real good railroad men who are opposed to the plan. There are many such, and they have some excellent reasons for objecting to the system which, I hope, will be brought forward now.

I think well of the idea of the system inaugurated by Mr. Brown, but think that the opinions expressed in your paper are entirely too favorable. In order to use the system satisfactorily, the greatest care must be used in its administration and it cannot be allowed to take care of itself as I believe many think it will do. It requires even more of the personal attention of the officers than the old plan of suspension, I do not believe I am wrong in thinking that the importance of this is not generally realized.

The debit and credit system, when looked at in one way, appears to be the fairest method of dealing with the faults and merits of men, but is it not very unfair to the younger men. The old and seasoned engineers, for example, very seldom get into trouble, and this is not entirely due to their reliability, but rather to a large extent to the fact that they have the best runs, where they are associated with the best crews and the most favorable conditions for satisfactory service. Not so with the younger men who are given the vastly more difficult work of handling the extras and way freights. It is easy to handle passenger trains and fast through freight, where the entire crews are selected for their good records as compared with the extra running and the handling of the trains that are not taken care of by the dispatchers and officers. A young man running extra has to put up with the worst of the crews and in my opinion he does not find the system so satisfactory. Also the young men who are running "extra" do not find the suspension so burdensome because they expect to "lay off" once in a while anyway, because of the fluctuations in business. Now, I submit that it is better for these men to be able to "clear up" their records by suspension, after getting into trouble, than to hold the record against them as long as they are on the road. While they may be judged to be to blame, it is true that their surroundings are often contributory and I think with "Master Mechanic," that the new plan discourages them and prevents them from doing their best work to put themselves on their feet again.

Another fault with the Brown system, and it is a serious one, is that when a crew desires to be relieved from association with a certain member, say a conductor or engineer, they can avail themselves of the opportunity to "snuff him out" after he has received nearly enough demerit marks to cause his dismissal. If a man has, say, 50 out of the 60 marks that would cause his discharge, the rest of the crew can easily report enough little things to secure the other 10 marks and get rid of the man without his being able to defend himself, and when he is not to blame.

There are other objections, and perhaps some that are more important than these, and, in fairness, they ought to be brought out and removed if possible because there is a great deal that is good in the system.

SUPT.

THE M. C. B. COUPLER ABROAD.

Editor "American Engineer:"

Since writing the communication on "The M. C. B. Coupler Abroad," printed in your February number (page 44), I have frequently heard the question asked, whether or not the vertical plane coupler, in its present form, as used in this country, is applicable to the European type of freight cars. As a matter of information, I would like to state that the Nessel-dorf Car Manufacturing Company, of the city of the same name, has recently, in co-operation with a large American car coupler company, brought out a draft rigging for that purpose, which is reported to be quite satisfactory. This is mentioned because it is one of the first designs in that line, showing that the idea is practical, and it will no doubt be followed by others suitable to the various makes and dimensions of cars.

The railroad men generally in Continental Europe have become familiar with most types of M. C. B. couplers used in this country, through visits here as well as through working models sent from here for that purpose. Information is also at hand to the effect that a test is at present being made on the Stramberg-Wendorf line with American couplers, and that a number of railroad men from Germany and other European countries have visited Stramberg during the last two or three months for the purpose of noting the performance of the couplers.

EDW. GRAFSTROM,

P. C. C. & St. L. Ry.

Columbus, O., March 13, 1899.

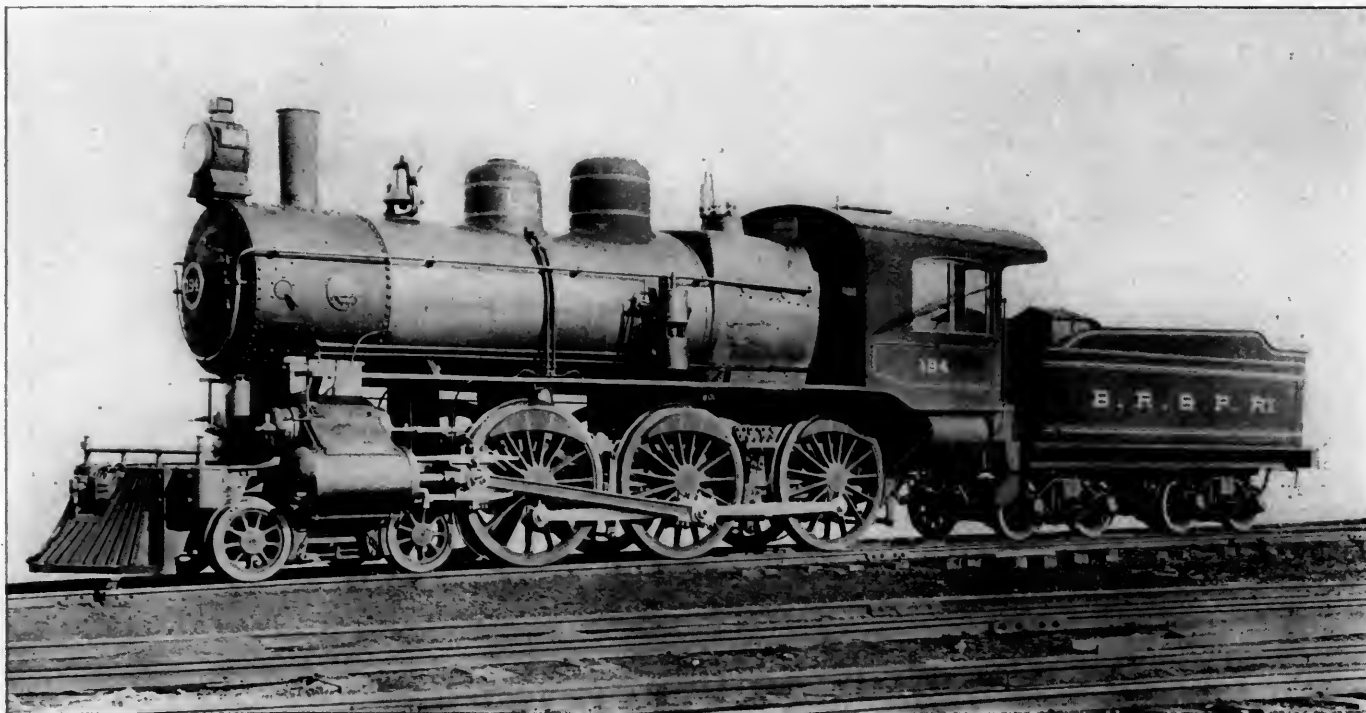
RAILROAD EARNINGS IN 1898.

The preliminary report of the income account of railways in the United States for the year ended June 30, 1898, reported to the Interstate Commerce Commission, has been issued. The report includes the returns of 720 lines, with an aggregate mileage of 181,333 miles. The receipts of the year were: Passenger service, \$333,892,782; freight service, \$874,865,487; other earnings from operation, \$30,765,111; gross earnings, \$1,238,523,380; operating expenses, \$811,241,458; income from operation, \$427,281,922.

The increase of gross earnings over the previous year was \$165,161,583. Operating expenses increased \$58,716,594, and income, \$57,716,913. Gross earnings per mile increased \$708; operating expenses, \$368; income, \$340. These are the largest figures reported since 1892, and the income account shows an increase of \$410 a mile over the report for 1894.

The total income of the railroads for the year 1897-98 was \$466,790,116. Dividends were paid amounting to \$65,995,515. Other deductions (interest on bonds, taxes, etc.), \$358,189,202, leaves a surplus from operations of the year of \$42,604,999. The corresponding item for the previous year showed a deficit from operations of \$1,412,399. Statistician Adams adds:

"The amount of dividends stated does not include those declared upon the stock of lines operated under lease. This report is confined to operating roads. The amount of dividends declared for operating roads exceeds the amount of dividends declared for the previous year by \$6,839,337. This fact, taken in connection with the increased surplus, suggests in another way the revival of prosperity for American railways."



Ten-Wheel Passenger Locomotive—Buffalo, Rochester & Pittsburgh Ry.
The Brooks Locomotive Works, Builders.

BROOKS TEN-WHEEL PASSENGER LOCOMOTIVE.

Buffalo, Rochester & Pittsburgh Railway.

The Brooks Locomotive Works have recently completed a lot of five ten-wheel passenger locomotives for the B., R. & P. Ry., which are represented by the accompanying illustration. These locomotives are of the simple type, with piston valves 10 inches in diameter and cylinders 18x26 inches. The valves are somewhat reduced in diameter from former sizes, and the valve stems are fitted with knuckle joints; the latter feature is an important return to old practice, for many still believe the old flexible connection between the valve rod and valve stem to be preferable in every respect to the later rigid form of connection, even if there is an extra joint to keep tight and free from lost motion.

The smokebox is Mr. J. Snowden Bell's patent short-form, with his spark arrester, its use in this design being another indication of the increasing popularity of short smoke boxes. The use of piston valves permits of a favorable location of the links and a good link radius. The valve stems are in line with the frames and directly over their centers, and it was not necessary to locate the rocker boxes with a view of getting them into a narrow space between the wheels. In this case the rocker boxes are placed below the upper bars of the frame and inside of the forward driving wheels. Both top and bottom rocker arms are inside of the frames and upon the inside end of the rocker shaft. The valve motion in this case is admirably direct. The lower rocker arms are connected directly to the link blocks, without the lever and hanger complications that are often used when the rocker shaft must come out between the driving wheels. This arrangement is as simple as that of an eight-wheel engine.

There is evidence of some attention to strength in the crank-pins, as calculation shows a fiber stress of 15,400 pounds per square inch on the main pins at the hub, under a bending moment due to boiler pressure, and assuming one pin to resist the whole force. This is an exceedingly favorable fiber stress, and the pins must be considered as safely designed, and they will probably give a good account of themselves. A departure in the arrangement of the front driving spring from former practice of these builders will be noted. This spring now passes under the frame directly to the top of the driving box,

dispensing entirely with the saddle. This effort to simplify design and reduce the number of pieces is commendable, but it is open to question whether springs should have rubbing contacts at their ends.

These engines will exert a starting effort of 22,000 pounds under very unfavorable rail conditions and without sand, having a weight of 108,000 pounds on drivers, which gives a ratio of tractive power to adhesive weight of 0.2.

Among the other features of the design we note the Player. Belpaire boiler, brakes on the truck wheels, the location of the driving brake cylinder under the boiler and immediately back of the forward axle. The top of the cylinder may be seen over the top of the forward driving wheel in the photograph. The brake shoes are behind the driving wheels. At the cylinders the frames widen into slabs 9½ inches deep by 4 inches wide. The leading dimensions of the design are given in the following table:

Ten-Wheel Passenger Locomotive.	
Gauge	4 ft. 8½ in.
Kind of fuel	Bituminous coal
Weight on drivers	108,000 lbs.
Weight " trucks	34,000 "
" total	142,000 "
" tender loaded	98,000 "
General Dimensions.	
" Wheel base, total of engine	24 ft. 3 in.
" " driving	14 ft.
" " total, engine and tender	51 ft. 10½ in.
Length over all, engine	37 ft. 2¾ in.
" " total, engine and tender	61 ft. 5½ in.
" Height, center of boiler above rails	9 ft. 1 in.
" of stack above rails	14 ft. 11½ in.
Heating surface, firebox	1,862 sq. ft.
" tubes	1,862 "
" total	2,028 "
Grate area	30.6 "
Wheels and Journals.	
" Drivers, diameter	69 in.
" material of centers	Cast steel
Truck wheels, diameter	30½ in.
Journals, driving axle	8½ in. x 10 in.
" truck	5½ in. x 10 in.
Main crank pin, size	6 in. x 5½ in.
Cylinders.	
Cylinders, diameter	18 in.
Piston, stroke	26 in.
Piston rod, diameter	3½ in.
Main rod, length center to center	116 in.
Steam ports, length	21 in.
" width	2 in.
Exhaust ports, least area	50 sq. in.
Bridge, width	3¼ in.
Valves.	
Valves, kind of	Improved piston
" greatest travel	7 in.
" steam lap (inside)	1¼ in.
" exhaust lap or clearance (outside)	¼ in.
" Lead in full gear (negative)	1-16 in.

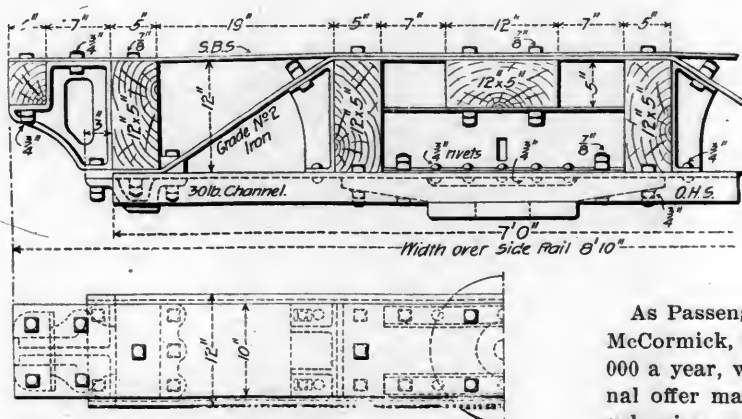
Boiler.	
Boiler, type of	Player improved Belpaire
" working steam pressure	200 lbs.
" thickness of material in barrel	$\frac{5}{8}$ in.
" " tube sheet	$\frac{3}{4}$ in.
" diameter of barrel	62 in.
Crown sheet, stayed with	Direct stays
Dome, diameter	30 in.
Firebox.	
Firebox, type	Long, over frames
" length	108 in.
" width	42 in.
" depth, front	75 in.
" " back	60 in.
" thickness of sheets	Crown, $\frac{3}{8}$ in.; tube, $\frac{5}{8}$ in.; side and back, $\frac{3}{8}$ in.
" brick arch	On studs
" mud ring width	Back, $3\frac{1}{2}$ in.; sides, $3\frac{1}{2}$ in.; front, 4 in.
" water space at top	Back, $4\frac{1}{2}$ in.; sides, 6 in.; front, 4 in.
Tubes, number of	272
" " outside diameter	3 in.
" length over tube sheets	13 ft. $2\frac{1}{4}$ in.
Smoke Box.	
Smoke box, diameter, outside	65 in.
" length from flue sheet	61 in.
Tender.	
Tank, capacity for water	4,500 gals.
" " coal	10 tons
Type of under frame	Steel channel
" springs	Double elliptic
Diameter of wheels	33 $\frac{1}{2}$ in.
" and length of journals	$4\frac{1}{2}$ in. x 8 in.
Length of tender over bumper beams	22 ft. $1\frac{1}{2}$ in.
" tank	19 ft. 6 in.
Width of tank	9 ft. 6 in.
Height of tank, not including collar	46 in.

BODY BOLSTERS FOR TENDERS.

Northern Pacific Railway.

The general substitution of metal for wood in bolster construction is marked not only in new car work, but also in the newer tender designs for either metal or wooden frames. In the accompanying engravings a metal bolster is shown adapted to a wooden frame of the type long representing the practice of the Northern Pacific, but which were equipped with wooden bolsters up to the time the subject of the illustration was devised. It is of a very simple character, made up of a 12-inch, 30-pound steel channel for a lower member and foundation for the center plate, and a $\frac{1}{2}$ by 12-inch tension member of iron, which passes over the center sills and joins the channels at the bottom of the outside sills.

On the top of the large channel, above the center plate, a pair of 7-inch steel channels extend from sill to sill and form a backing between the lower member of the bolster and the center longitudinal timber of the tender frame, thus giving sufficient rigidity at this point to overcome the reaction of the center plates. The center plates are of cast iron fitting in between the flanges of the channel with a bearing length of 34



Body Bolster for Tenders.
Northern Pacific Railway.

inches, which also lends additional stiffness at the point where it is required.

Attention is directed to the security of fastening of the members at their junction at the ends. The upper piece after passing under the outside sills is bent on itself so as to form a foot which abuts against the web of the channel and continues out

to take a bolt through the bracket supporting the outer rail of the frame. The bolt also passes through the outer flange of the side bearing, and a similar bolt passes through the inner flange and channel. One of the most important features of this bolster is wide range of adaptability, as it is designed for and can be used on tenders of all classes of engines with wooden frames, old and new alike. We acknowledge the courtesy of Mr. Wm. Forsyth, Superintendent of Motive Power, for the drawing of this design.

THE AMERICAN CAR AND FOUNDRY CO.

The following is a statement of the car building concerns which have united under the name of the American Car and Foundry Co., and their officers, as received from Mr. W. K. Bixby, President of the Company:

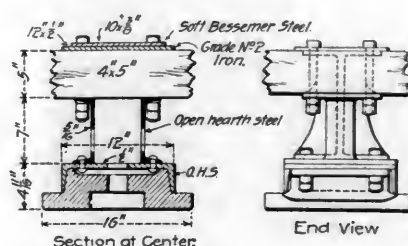
Michigan Peninsular Car Co., of Detroit.
Jackson & Woodin Mfg. Co., of Berwick, Pa.
Missouri Car and Foundry Co., of St. Louis, Mo.
Ohio Falls Car Co., of Jeffersonville, Ind.
Union Car Co., of Buffalo, N. Y.
St. Charles Car Co., of St. Charles, Mo.
Wells & French Co., Chicago, Ill.
Terre Haute Car and Mfg. Co., of Terre Haute, Ind.
Pennock Brothers, Minerva, O.

The officers are: Mr. W. K. Bixby, President; Mr. Fred H. Eaton, Vice-President and Acting Treasurer; Mr. W. J. McBride, General Auditor. The Secretary has not yet been elected.

Mr. Bixby's office is to be in New York, as are also the offices of the Treasurer and Auditor. Mr. William McMillin is chairman of the Board of Directors, and the Directors are as follows:

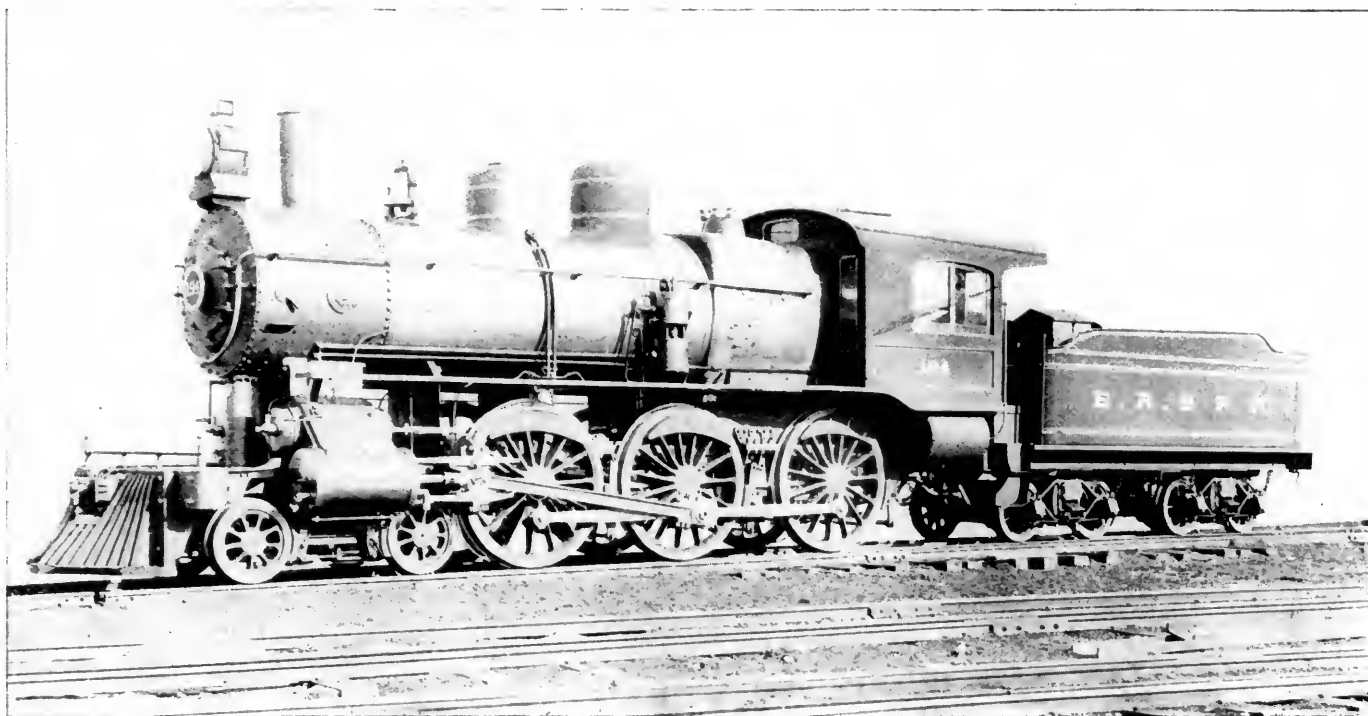
Mr. W. K. Bixby, Missouri Car and Foundry Co.; Mr. George Hargreaves, Michigan Peninsular Car Co.; Mr. J. L. Smyser, Ohio Falls Car Co.; Mr. Fred H. Eaton, Jackson & Woodin Mfg. Co.; J. J. Albright, Union Car Co.; Mr. Lewis J. Cox, Terre Haute Car and Mfg. Co.; Mr. H. B. Denker, St. Charles Car Co., and Mr. Charles T. Schoen, Pressed Steel Car Co.

The authorized stock of the American Car and Foundry Co. is \$30,000,000 of 7 per cent. non-cumulative preferred stock and \$30,000,000 of common stock, of which \$2,400,000 of preferred and the same amount of common stock are to be retained in the treasury.



As Passenger Traffic Manager of the Southern Pacific, E. A. McCormick, it is said, will receive the handsome salary of \$17,000 a year, with a five-year contract. This was not the original offer made by the Southern Pacific people, but they kept enlarging on that until the figures reached a point where it was too tempting to refuse, especially as President Ingalls, of the Big Four, advised its acceptance, the amount being greater than he could ever give Mr. McCormick. This is not Mr. McCormick's first flattering offer, but exceeds all others in the inducements offered.

Mr. John Player, who has been chief draftsman of the Brooks Locomotive Works for a number of years, has been promoted to the position of Mechanical Engineer.



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The smokebox is Mr. J. Snowden Bell's patent short-form, with his spark arrester, its use in this design being another indication of the increasing popularity of short smoke boxes. The use of piston valves permits of a favorable location of the links and a good link radius. The valve stems are in line with the frames and directly over their centers, and it was not necessary to locate the rocker boxes with a view of getting them into a narrow space between the wheels. In this case the rocker boxes are placed below the upper bars of the frame and inside of the forward driving wheels. Both top and bottom rocker arms are inside of the frames and upon the inside end of the rocker shaft. The valve motion in this case is admirably direct. The lower rocker arms are connected directly to the link blocks, without the lever and hanger complications that are often used when the rocker shaft must come out between the driving wheels. This arrangement is as simple as that of an eight-wheel engine.

There is evidence of some attention to strength in the crank-pins, as calculation shows a fiber stress of 15,400 pounds per square inch on the main pins at the hub, under a bending moment due to boiler pressure, and assuming one pin to resist the whole force. This is an exceedingly favorable fiber stress, and the pins must be considered as safely designed, and they will probably give a good account of themselves. A departure in the arrangement of the front driving spring from former practice of these builders will be noted. This spring now passes under the frame directly to the top of the driving box,

dispensing entirely with the saddle. This effort to simplify design and reduce the number of pieces is commendable, but it is open to question whether springs should have rubbing contacts at their ends.

These engines will exert a starting effort of 22,000 pounds under very unfavorable rail conditions and without sand, having a weight of 108,000 pounds on drivers, which gives a ratio of tractive power to adhesive weight of 0.2.

Among the other features of the design we note the Player, Belpaire boiler, brakes on the truck wheels, the location of the driving brake cylinder under the boiler and immediately back of the forward axle. The top of the cylinder may be seen over the top of the forward driving wheel in the photograph. The brake shoes are behind the driving wheels. At the cylinders the frames widen into slabs 9½ inches deep by 4 inches wide. The leading dimensions of the design are given in the following table:

Ten-Wheel Passenger Locomotive.	
Gauge	4 ft. 8½ in.
Kind of fuel	Bituminous coal
Weight on drivers	108,000 lbs.
" " trucks	34,000 "
" " total	142,000 "
" tender loaded	98,000 "
General Dimensions.	
" Wheel base, total of engine	21 ft. 3 in.
" " driving	11 ft.
" " total, engine and tender	31 ft. 10½ in.
Length over all, engine	37 ft. 2½ in.
" " total, engine and tender	61 ft. 5½ in.
" Height, center of boiler above rails	9 ft. 1 in.
" " of stack above rails	14 ft. 11½ in.
Heating surface, firebox	1,166 sq. ft.
" " tubes	1,862 "
" " total	3,028 "
Grafe area	30.6 "
Wheels and Journals.	
" Drivers, diameter	30 in.
" " material of centers	Cast steel
Truck wheels, diameter	30½ in.
Journals, driving axle	8½ in. x 10 in.
" truck	5½ in. x 10 in.
Main crank pin, size	6 in. x 5½ in.
Cylinders.	
Cylinders, diameter	18 in.
Piston, stroke	26 in.
Piston rod, diameter	3½ in.
Main rod, length center to center	116 in.
Steam ports, length	21 in.
" width	2 in.
Exhaust ports, least area	50 sq. in.
Bridge, width	30 in.
Valves.	
Valves, kind of	Improved piston
" greatest travel	1 in.
" steam lap (inside)	1¼ in.
" exhaust lap or clearance (outside)	¼ in.
" Lead in full gear (negative)	1-16 in.

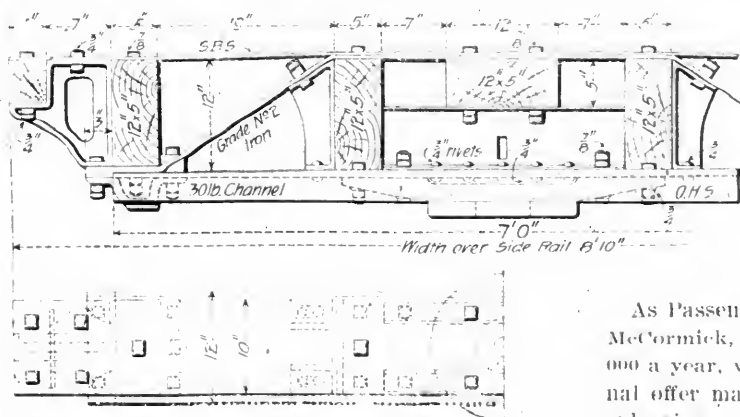
Boiler.	
Boiler, type of.....	Player improved Belpaire
" working steam pressure.....	200 lbs.
" thickness of material in barrel.....	5/8 in.
" " tube sheet.....	3/4 in.
" diameter of barrel.....	32 in.
Crown sheet, stayed with.....	Direct stays
Dome, diameter.....	30 in.
Firebox.	
Firebox, type.....	Long, over frames
" length.....	108 in.
" width.....	12 in.
" depth, front.....	75 in.
" " back.....	60 in.
" thickness of sheets.....	Crown, 5/8 in.; tube, 5/8 in.; side and back, 3/8 in.
" brick arch.....	On studs
" mud ring width.....	Back, 3 1/2 in.; sides, 3 1/2 in.; front, 4 in.
" water space at top.....	Back, 4 1/2 in.; sides, 6 in.; front, 4 in.
Tubes, number of.....	272
" outside diameter.....	3 in.
" length over tube sheets.....	13 ft. 2 1/4 in.
Smoke Box.	
Smoke box, diameter, outside.....	65 in.
" length from flue sheet.....	61 in.
Tender.	
Tank, capacity for water.....	1,500 gals.
" " coal.....	10 tons
Type of under frame.....	Steel channel
" springs.....	Double elliptic
Diameter of wheels.....	33 1/2 in.
" and length of journals.....	14 in. x 8 in.
Length of tender over bumper beams.....	22 ft. 1 1/2 in.
" " tank.....	19 ft. 6 in.
Width of tank.....	9 ft. 10 in.
Height of tank, not including collar.....	46 in.

BODY BOLSTERS FOR TENDERS.

Northern Pacific Railway.

The general substitution of metal for wood in bolster construction is marked not only in new car work, but also in the newer tender designs for either metal or wooden frames. In the accompanying engravings a metal bolster is shown adapted to a wooden frame of the type long representing the practice of the Northern Pacific, but which were equipped with wooden bolsters up to the time the subject of the illustration was devised. It is of a very simple character, made up of a 12-inch, 30-pound steel channel for a lower member and foundation for the center plate, and a 1/2 by 12-inch tension member of iron, which passes over the center sills and joins the channels at the bottom of the outside sills.

On the top of the large channel, above the center plate, a pair of 7-inch steel channels extend from sill to sill and form a backing between the lower member of the bolster and the center longitudinal timber of the tender frame, thus giving sufficient rigidity at this point to overcome the reaction of the center plates. The center plates are of cast iron fitting in between the flanges of the channel with a bearing length of 34



Body Bolster for Tenders.
Northern Pacific Railway.

inches, which also lends additional stiffness at the point where it is required.

Attention is directed to the security of fastening of the members at their junction at the ends. The upper piece after passing under the outside sills is bent on itself so as to form a foot which abuts against the web of the channel and continues out

to take a bolt through the bracket supporting the outer rail of the frame. The bolt also passes through the outer flange of the side bearing, and a similar bolt passes through the inner flange and channel. One of the most important features of this bolster is wide range of adaptability, as it is designed for and can be used on tenders of all classes of engines with wooden frames, old and new alike. We acknowledge the courtesy of Mr. Wm. Forsyth, Superintendent of Motive Power, for the drawing of this design.

THE AMERICAN CAR AND FOUNDRY CO.

The following is a statement of the car building concerns which have united under the name of the American Car and Foundry Co., and their officers, as received from Mr. W. K. Bixby, President of the Company:

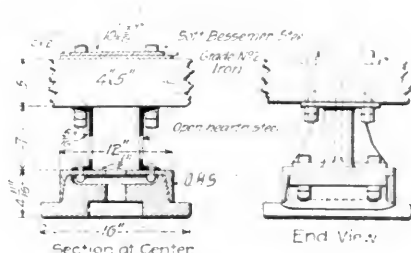
Michigan Peninsular Car Co., of Detroit.
Jackson & Woodin Mfg. Co., of Berwick, Pa.
Missouri Car and Foundry Co., of St. Louis, Mo.
Ohio Falls Car Co., of Jeffersonville, Ind.
Union Car Co., of Buffalo, N. Y.
St. Charles Car Co., of St. Charles, Mo.
Wells & French Co., Chicago, Ill.
Terre Haute Car and Mfg. Co., of Terre Haute, Ind.
Pennock Brothers, Minerva, O.

The officers are: Mr. W. K. Bixby, President; Mr. Fred H. Eaton, Vice-President and Acting Treasurer; Mr. W. J. McBride, General Auditor. The Secretary has not yet been elected.

Mr. Bixby's office is to be in New York, as are also the offices of the Treasurer and Auditor. Mr. William McMillin is chairman of the Board of Directors, and the Directors are as follows:

Mr. W. K. Bixby, Missouri Car and Foundry Co.; Mr. George Hargreaves, Michigan Peninsular Car Co.; Mr. J. L. Smyser, Ohio Falls Car Co.; Mr. Fred H. Eaton, Jackson & Woodin Mfg. Co.; J. J. Albright, Union Car Co.; Mr. Lewis J. Cox, Terre Haute Car and Mfg. Co.; Mr. H. B. Denker, St. Charles Car Co., and Mr. Charles T. Schoen, Pressed Steel Car Co.

The authorized stock of the American Car and Foundry Co. is \$30,000,000 of 7 per cent. non-cumulative preferred stock and \$30,000,000 of common stock, of which \$2,400,000 of preferred and the same amount of common stock are to be retained in the treasury.



As Passenger Traffic Manager of the Southern Pacific, E. A. McCormick, it is said, will receive the handsome salary of \$17,000 a year, with a five-year contract. This was not the original offer made by the Southern Pacific people, but they kept enlarging on that until the figures reached a point where it was too tempting to refuse, especially as President Ingalls, of the Big Four, advised its acceptance, the amount being greater than he could ever give Mr. McCormick. This is not Mr. McCormick's first flattering offer, but exceeds all others in the inducements offered.

Mr. John Player, who has been chief draftsman of the Brooks Locomotive Works for a number of years, has been promoted to the position of Mechanical Engineer.

FAIRBANKS-MORSE DIRECT-CONNECTED AIR COMPRESSOR.

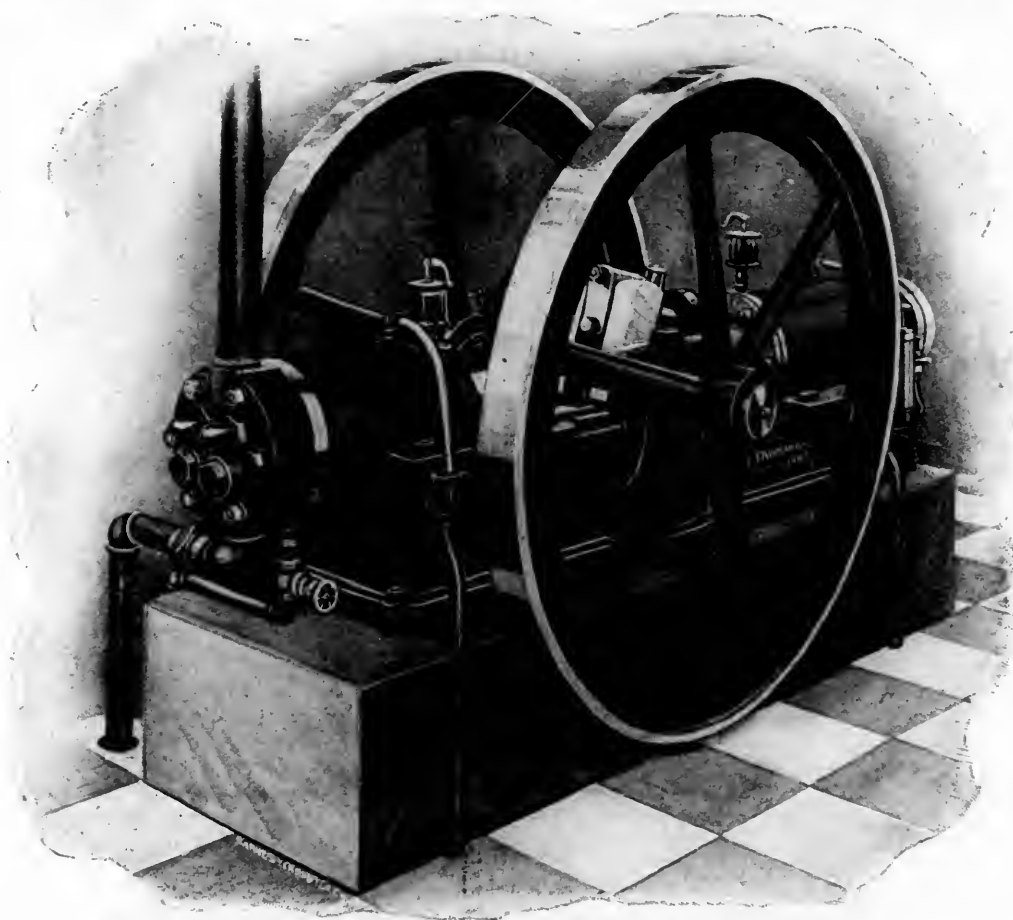
Using Gas, Gasoline and Distillate.

This machine fills a long felt want, both as a portable or field machine, and as a compact and simple stationary compressor. For ordinary shop work it has not been difficult to arrange either a steam or power driven air compressor to furnish air for the various requirements about the shop and factory, but when field work in general was considered the obstacles encountered were prohibitory for using any of the present forms of compressors.

This compressor is self contained; constructed with one bed plate carrying the two cylinders placed opposite, one on each side of the crank. The air piston is direct-connected to the power piston by distance rods. The crank shaft of the engine

machines upon one side of the rails without interfering with traffic while the bridge is being altered. This compressor has also been mounted on trucks, making a complete, self contained, portable combination, which is very useful in ship yards, and one is now in use by the Cleveland Shipbuilding Company, at Lorain, Ohio, for riveting, drilling, reaming, chipping and caulking. It may be drawn about from place to place while running if necessary. Another has just been ordered for use in a large shipyard in Scotland.

This engine and compressor is useful for many purposes, such as the testing of air brakes, and the pumping of water by an "air lift." In case a terminal testing plant should be installed, the compressor, delivering air into a large receiver, would supply the air for testing brakes in yards where a large number of freight cars are daily handled, thus saving time and expense as well as delay, which would be necessary if the brakes were to be tested and charged by admitting air from the



Fairbanks-Morse Direct Connected Gasoline Engine and Air Compressor.

controls the length of stroke, and the speed of both the engine and compressor. Through the medium of the crank and heavy fly wheels, a positive and uniform speed is maintained. Large and ample valve area is provided for the air cylinder; the valves being made with removable seats easy of access, while the engine used is the well known Fairbanks-Morse gasoline engine. This combination permits of placing the engine in any desired location, either upon the work being constructed or near at hand. In bridge work it is customary to locate the compressor near the end of the bridge, as work is commenced, and, by a pipe line, air is conveyed to the bridge, where it is used for operating pneumatic riveters, drills and chipping tools. On the Illinois Central R. R. compressors are located in the middle of the bridges and on the swing spans of draw-bridges, the piping being carried both ways from the compressor. In the repairing or strengthening of old bridges, the compressor is frequently located on the bridge which is being altered. Little space is occupied, and it is not difficult to place one of these

locomotive before the train was started. It could be used effectively in connection with a testing yard such as the one described on page 74 of our March issue.

As the compressor is automatic in its action little attention is required after starting. The expense for fuel for operating is very small, as the governor admits either gas or gasoline in exact proportion to the amount of work applied. Therefore, if the amount of air used is small, the amount of fuel required will also be small, and as in either of the above cases the work is more or less intermittent, the saving would be large over any other known power. These compressors are built in several sizes, ranging from 70 to 360 cubic feet of free air per minute.

A number are already in use in railroad service. A representative of this journal recently inspected an installation at what is known as the "B O" signal tower at the west end of the Altoona yards of the Pennsylvania Railroad, where the compressor will be used to supply power for operating electro-pneumatic switch apparatus, besides furnishing air for charg-

ing and testing air brakes in the yard. Its chief recommendations for such service, besides economy, are the absence of fire and the small amount of attention required. As the engines regulate themselves, very little attention is required except to start and stop them and fill the lubricators.

A 12 horse power engine of this type is now in use on the bridge work of the Erie track elevation in Jersey City. It is mounted in a box car, and often runs four and five hours without any attention, the car doors being closed and locked except when the engine is started and stopped. On this work the compressor furnishes power for riveters made by the Chicago Pneumatic Tool Company, and its use rendered it possible to increase the amount of work from an average of 300 $\frac{5}{8}$ -inch and $\frac{7}{8}$ -inch rivets per day, by two men and two boys, to 1,200 $\frac{5}{8}$ -inch or 1,000 $\frac{7}{8}$ -inch rivets per day driven by one man and three boys, the work being now more satisfactory. This compressor furnishes 70 cubic feet of free air compressed to 80 pounds pressure per minute, at a cost of 12 cents per hour. We are informed that on a single ship recently built by the Detroit Dry Dock Company a saving of \$2,700 was effected on the riveting of three decks by the use of a compressor and pneumatic riveters.

The Boston & Maine Railroad has installed a 12-horse power engine and compressor in a box car for use in cleaning bridges with the sand blast and also for painting them. The Canada Atlantic has recently ordered one and an unusual amount of interest is shown in them by railroad men. Lieut.-Col. Milton B. Adams, U. S. A., Engineer of the Eleventh Lighthouse District at Detroit, recently made a test of a 34 H. P. Fairbanks-Morse gasoline air compressor at the Beloit Works of the company and examined the machines for use in operating fog sirens and whistles. The report was very favorable, and the board was instructed to purchase two of them. The constant expense of keeping up steam pressure in the present equipment would be an important item in favor of gasoline engines in this service.

Our representative recently inspected one of these compressors in use at the new Appellate Court Building, Madison Square, New York. Jos. Smith & Co., who have the contract for the ornamental stone carving on the building, are using it to furnish air for seventeen sculptors who are using pneumatic tools. The compressor is running in a shed on a rough staging about 12 feet above the sidewalk. It has no foundation except that of the staging that was built to hold the ladders for the workmen, and it is working with only such attention as the man who puts up the stagings and assists the sculptors can give it. This means that it is merely oiled and looked at occasionally. This compressor furnishes air for seventeen tools using 4 cubic feet of free air per minute and uses city gas. At \$1.10 per thousand it costs \$1.60 per day to run these tools, and while we could not learn the amount of saving effected over hand work it is evident that the contractor is very happy to have the compressor, and this installation is a good example of the adaptability of the machine for rough and ready conditions. From these examinations of the machines, it is made apparent that they are to be very successful, and that a great many will be used.

We are informed that the Manhattan Elevated Railway, of New York, has just ordered a 12 horse power gasoline engine and compressor to be used on the elevated structure. Compactness and portability are important in such service.

Resumption of work on the Hudson River tunnel seems to be a reasonable possibility. The company is agitating the subject again, and a report is to be made upon it by Messrs. Sooy-smith & Co. The East River tunnel of the New York & Long Island Railway Co. is also discussed again. It was started seven years ago and abandoned. The plan was to cross at Forty-second street. It is stated that attempts to raise capital are now being made.

NEW ENGLISH AND GERMAN PASSENGER LOCOMOTIVES

In England and on the Continent locomotive designers are making strong efforts to get away from the diminution lines that have been the prevailing characteristics of their locomotives, and are trying incidentally to increase the heating surface consistent with more powerful machines. To one who is abroad for the first time there are surprises in plenty when the attempt is made to compare the heavy passenger power with our own, for the reason that there is nothing over there directly comparable, and while this condition may continue for some time owing to many restrictions that are uncontrollable by the locomotive designer, improvements are under way that will be sure to do away with the light engines now so common on many lines.

One of the latest examples of the improvements for passenger service is the engine designed by Mr. H. A. Ivatt, Locomotive Superintendent of the Great Northern Railway of England. These engines have some points strikingly similar to our "Atlantic" type. They are four wheel connected with inside valve chests and outside cylinders, and also have trailing wheels. These engines have a 56-inch straight boiler with 140 square feet of heating surface in the firebox and a total of 1,302 square feet, with a grate area of 26.75 square feet. The cylinders are 19 by 24 inches, boiler pressure 175 pounds, and drivers 81 inches diameter. The weight of the engine is 130,000 pounds, the total of engine and tender is 220,000 pounds, and weight on drivers 69,440 pounds. These figures indicate the sentiment now stirring the English roads to cope with the increased weight of their passenger trains.

Some new engines built at Munich for the Westphalian lines, very closely follow the above in general proportion, having cylinders 19.25 by 22 $\frac{3}{4}$ inches, and drivers 78.25 inches diameter. The total heating surface is 1,848 square feet, and grate area 30.25 square feet. The diameter of the boiler is 57 inches, designed for 191 pounds steam pressure. The weight is 128,970 pounds; weight on drivers 66,140 pounds, and weight of engine and tender loaded is 216,000 pounds. This engine is also four wheel connected and has a pair of trailing wheels, but has inside cylinders. The German engine, like the English one, was designed for having fast passenger service under the most trying conditions of grade and curves, and ranks in that respect as a decided advance over the older types of locomotives. A comparison of the starting power of these engines shows the English design to be able to exert a pull of 16,800 pounds, while the corresponding power of the German engine is 18,200 pounds, but the former engine, owing to the adhesive weight, will be able, even with 81-inch wheels, to force the train into speed quicker than the latter under average conditions of rail.

HOT JOURNALS.

The effect of pouring cold water over hot journals has been discussed a great deal and was one of the topics before the Western Railway Club at its February meeting. It appears to be uncertain just what the effect of the cold water is, but several officers reported that they now insist on removing axles from passenger service after they have been hot enough to require artificial cooling. Several cases of broken axles have been traced to a previous excessive heating of the journals. In answer to the question as to the causes for hot boxes, Mr. J. N. Barr said:

"I believe it would be a great deal harder to answer the question: 'Why don't we have more?' When you consider the weight per square inch of bearing on every car running on our roads, and look at our mechanical appliances and find that we are carrying two or three times the weight per square inch it is safe to run journals on, and that we are making an average of 40,000 or 50,000 miles per car per hot journal, it seems to me that it would be a great deal harder question to answer if it were asked: 'Why don't we have more hot boxes than we actually have?'"

(Established 1832)

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Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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Opinion on the Brown system of discipline is now in this country almost universally favorable. It seems to furnish a measure of that vital influence of human interest which is necessary for harmonious co-operation among men who are working together. The system is not by any means in universal use, but its adoption by over 50 railroads, and the all but perfect unanimity of favorable opinion indicate its standing in railroad management. Opinions of foreign railroad papers as recently expressed to the effect that it does very well for small roads, "such as the Fall Brook," and that it "smacks too much of militarism and Pinkertonism," will probably undergo revision when its real standing and importance are understood.

A third man on the engine or some satisfactory method of communication between the engineers and firemen on engines of the Wootten type was the recommendation of the New York State Railroad Commission, as noted last month. A bill has been prepared for the New York State Legislature which, if passed, will go a long way beyond the intention of the commission. The bill requires two regularly licensed engineers in charge of each locomotive in passenger service without mentioning the Wootten type. The object of this proposition would be attained by providing means for communication between the engineer and fireman. This done, we cannot see any advantage in putting on a third man. It is probable that in the case of a Wootten locomotive the third man would not himself discover an accident to the engineer, but would remain in ignorance of it until informed by the fireman. The idea seems "far fetched" and ill considered, and the bill ought not to pass. It probably will not become a law.

The controversy between the "line and staff" in the navy has been settled by the passage of the "Navy Personnel bill," the principle feature of which is the amalgamation of the line officers with the engineers. All officers will be line officers, and those who choose may go into the engineering work, but they will still be line officers in all respects. This does well as far as patching up the recent difficulties is concerned, but it does not settle the question permanently. It puts off the evil day because it is probable that the engines will be intrusted to the care of enlisted men who in time must have recognition. At one time we anticipated a rather different result of this bill and hoped to see the engineer predominate. The best captain or admiral, under modern conditions, would be still better if he came to his position through the engine room. But the bill is passed, and it is hoped that symptoms of belittling the men who are responsible for running the engines will not appear again.

Uniformity in general dimensions of car details has been a subject before the car builder for years without the remotest prospect of a satisfactory result, and it is not an unreasonable supposition that the work of the M. C. B. committee engaged on the sill question for 1899 may be able to present some propositions for the future. There is no doubt that the heterogeneous features of this question are due entirely to want of organized effort to straighten them out. In the case of sills, for example, there is need of concerted action, if from no other point of view than a mechanical one. It is certainly absurd for one builder to put six sills of certain dimensions into a car, and another eight sills in the same capacity of car, and different sizes of sills at that. The absurdity is all the more apparent when even tyros ought to know that a sill cannot of itself carry any part of the load imposed on it. Uniformity is wanted in posts braces and plates as well as in the lower members, and some means ought to be devised to bring this about. There are no arguments against it, and there are many good ones for it.

The proposed organization of the junior members of the American Society of Mechanical Engineers for the purpose of holding regular meetings for presentation of papers should be encouraged and assisted to completion. The senior membership will be improved by it, both now and later, when the present juniors become seniors. Many of the junior members are qualified to prepare papers and discuss them well, they need the benefits of contact with others who are working out engineering problems more even than do the seniors, and the value of such discussion is everywhere recognized. The character of the future papers and discussions before the seniors will be affected in an important way by the success of this movement, and it is hoped that the juniors will persevere and carry out the plan. The national societies of England have done wisely in encouraging the student membership in this way. It is strange that the idea was not started in this country before.

An amusing example of roundabout "labor saving" methods, where direct ones are better and easier, was mentioned by Mr. J. N. Barr, in a discussion on the uses of compressed air, before the Western Railway Club recently. An air hoist, rigged from the smokestack of a locomotive and arranged to lift the steam chests and steam chest covers, was illustrated in the technical press as an improvement. On ascertaining the relative weights of the air hoist and the articles to be lifted, it was found to require less labor to put up the chests and covers direct than to lift the hoist for attachment to the stack.

Air hoists have been built for loading wheels from the ground into cars at shops where the wheels are mounted. These appliances facilitate the work of loading and they should be used where necessary. Before putting in such an arrangement it would be well to examine the conditions with reference to the possibility of using a depressed track, which may be used for loading other articles and costs nothing for operation and very little for maintenance. Air appliances are so convenient that they are often used because they offer the easiest solution of a difficulty or the cheapest means for securing an improvement. The first cost is not the only cost, however.

Compressed air has been used for producing a blast for forges, and, while it has been believed to be extravagant in the use of power, it remained for Mr. J. F. Deems to indicate the degree of wastefulness. By a simple apparatus, consisting of a small jet nozzle opening into a funnel and discharge pipe, he produced a blast. When the conditions were examined by gauges it was found that this blast cost twenty-five times as much as one produced by a fan. The blast method may, however, be used where it is impossible to employ a fan.

The desirability of attaching air compression cylinders to shop engines in tandem arrangement was questioned by Mr. Thomas Paxton in the discussion referred to. The nature of the work done by the shop engine requires the load to be carried at a constant speed, while the reverse of this is expected from an air compressor. The compressor should maintain a fixed pressure or load regardless of its speed. No doubt master mechanics have sometimes been driven to use such a plan because of the difficulties in securing the appropriation necessary to purchasing a proper compressor. Mr. Paxton said: "Good practice dictates that such machines shall give place to the regulation compressor whenever it is possible. Gasoline engines are now combined with air compressors, with the two cylinders direct connected and mounted on the same bed plate. We illustrate one of these in this issue, and with such machines and the other improved compressors available, there should be no extension of the tandem practice as applied to steam engines.

COMPOUND LOCOMOTIVES.

As the compound locomotive is made the subject of careful study, opinions which have been adverse from the start are changing in favor of the type. It is beginning to appear that objections have sometimes been raised to the type when they really apply only to details of design and often to such details as frames and other parts which were not prepared for the stresses imposed upon them and should not be charged against the type. The treatment of compounds before the Western Railway Club last month was noteworthy because the type was now generally accepted as a satisfactory machine as a result of the elimination of weaknesses and a general improvement in the design of the parts rendering them suitable for the peculiar conditions. This may be summed up in this way: The faults of recent compounds are not often those of what may be termed the features of compounding. For some time we have believed that when so well designed that they will not break down on the road, and when the proportions are so chosen that they are satisfactory from an operating standpoint, compound locomotives will come into general use wherever they are used intelligently with a view of adapting them to conditions of operation. It is probable that they will give best results when worked continually up to their most favorable capacity, and a level division where the conditions are very nearly constant will probably be found to be their best field in freight service. It has also been shown that their reserve power obtained by working live steam in both cylinders is exceedingly valuable at critical points near the summits of heavy grades.

The adaptation of locomotives to the particular divisions to which they are assigned is as important a factor in operation as that of increasing their power, and until this fact was appreciated the compound has labored under a serious disadvantage.

The adaptability of the compound to heavy high speed service is forcing itself for attention, and opinions on their advantage for such service are likely to undergo revision very soon. The conditions under which four cylinder compounds are running in France are so different from ours as to prevent comparisons in regard to fuel economy, but the reports of their powers of acceleration, which are commented upon elsewhere in this issue, are interesting as are also the opinions of that type which are offered by the designer.

The general trend of opinion at this meeting was in marked contrast to the tone of previous discussion, and indicated that the compound has many strong advocates, some of whom have only recently become such.

CYLINDER CAPACITIES OF RECENT HEAVY LOCOMOTIVES.

There is an apparently strong tendency among locomotive designers to return to the early practice of giving to locomotives cylinder power closely approaching the limit of adhesion of the wheels to the rail, or, in other words, to give such a high ratio of power, developed in the cylinders to the adhesive weight, as to "over-cylinder" the engines. With the present practice of building large boilers, high cylinder power has a very different significance from that of the time when the cylinders were the governing factor in rating the power of locomotives and boiler capacity was entirely ignored. Then locomotives were crippled in two ways; namely, by a lack of heating surface and steam capacity, and inability to haul a tonnage commensurate with the size of cylinders and pressure, because of an insufficient weight on the wheels to utilize the power in the cylinders. While the newer designs show this slipping tendency, ample provision is made for heating surface and steam storage, and thus the means taken to correct the disadvantages of the small boiler also furnish the weight to hold the modern engine to the rail, and there is little left now as a relic of the old design, except the large cylinder capacities. That there are good reasons for these large cylinder proportions there

can be no question, since an engine is required to exert a maximum drawbar pull for short periods of time only, and this may be done by the aid of sanding appliances, and locomotives may, therefore, be built lighter for a given service, which is an item of no small account to the department of maintenance of way.

In another column of this issue will be found a comparison of the tractive powers of the heaviest engines ever built, which includes both the simple and four-cylinder compound types having the same boiler pressure. The heaviest of these, a simple engine, will develop 3,900 pounds less starting effort than the Lehigh Valley Vaucrain compound, although weighing 5,000 pounds more than the latter engine, which has a ratio of tractive power to adhesive weight of practically 0.30, as against 0.27 for the simple engine. It is evident that the compound must start on sand under ordinary conditions when exerting the full cylinder power, but when once in motion there will be 5,000 pounds less weight to tax the cylinders than in the case of the simple engine. This 5,000 pounds, at 8 cents per pound, means \$400 more for the simple engine than for the compound of greater capacity, which, from a financial point of view, might appear to be well worthy of consideration. If the simple engine had cylinders 23.75 inches diameter instead of 23 inches it would develop the same effort at the rail as the compound, and at the same time be less liable to slip, owing to the lower ratio of tractive power to adhesive weight.

A comparison of the two consolidations, with 62-inch wheels, one simple and the other compound, described elsewhere in this issue, shows that the cylinders of the simple engine would require to be 23 inches instead of 21 inches to develop the same power as the other engine exactly similar except in cylinder arrangement. Attention is called to these examples of heavy locomotives, for the reason that no claim has been made that the compound is more powerful than the simple engine it is built to replace, economy being the point insisted on. The importance of heating surface in its bearings on the cases noted is not overlooked, but there appears to be an opening more promising for compounds of the four-cylinder type of any build than for either a simple engine or a two-cylinder compound for heavy service, the cylinder size limit being reached much sooner in the latter types than in the former.

GRATES, LARGE VS. SMALL.

Bituminous coal burned successfully in locomotive fireboxes of the Wootten type is a novelty which is full of interest on account of its bearing on the question of large and small grates. The tests on the Philadelphia & Reading, which were recently carried out under the direction of Mr. E. E. Davis, Assistant Superintendent Motive Power, and reported by Mr. Vaughan in this issue, do not appear to prove that Wootten fireboxes are superior to those of the narrow type for bituminous coal, but they do show the possibility of burning that coal in very wide fireboxes without loss in economy. There seems to be justification for the conclusion that if the wide firebox had been deep enough to remove the crown sheet out of the fire, the result would have been more favorable to the Wootten boiler.

The tests by Prof. Goss on the effects of different rates of combustion, the recent fuel tests on the "Big Four" Railway and other experiments have, apparently, not tended to confirm D. K. Clark's conclusion in favor of small grate areas. We say apparently, because it is possible that Clark's proposition has not been fully understood. He said: "There may be too much grate area for economical evaporation, but there cannot be too little, so long as the required rate of combustion per square foot does not exceed the limits imposed by physical conditions."

If Clark thought of sparks when he spoke of "the limits im-

posed by physical conditions," his often quoted maxim is more favorable to wide fireboxes and large grates than interpreters have been willing to admit. Clark used coke in his famous experiments, and it is evident that the spark losses would be very different between coke and bituminous coal.

Mr. Vaughan found that with good firing an advantage was obtained by using the entire grate area of the Wootten boiler while burning soft coal, and this experiment was the starting point of the more elaborate tests. He found that he could use a slightly larger exhaust nozzle, and that fewer sparks were thrown from the stack when the entire grate was used. In the road tests these observations were confirmed by the comparisons of two boilers, which were as nearly alike as a Wootten and a narrow firebox boiler can be alike. The fuel was referred to the evaporation of water, and we believe the comparisons to be as fair as it is possible to obtain from road tests. The tests extended through six weeks, and every precaution was taken to secure data concerning the coal and water, with a view of making comparisons.

Mr. Vaughan's comments upon the probable performance of soft coal in the Wootten boiler when forced are suggestive. The rate of combustion would increase but it could never reach the high rates attained by narrow fireboxes, and as Mr. Vaughan says the narrow firebox would show a decrease of efficiency under the forcing on account of the spark losses. These tests did not probe the spark question completely, but Prof. Goss has shown us what to expect in this direction.

For a complete understanding of this subject of grate areas, several important factors besides the grate areas must be considered. The front end arrangements, the temperature of the smokebox, the effectiveness of the heating surfaces, the admission of air through the grates and through the fire door, the methods of firing and the spark losses. Prof. Goss found the spark losses in the tests reported in our issue of October, 1896, (page 255), to equal in value all other losses occurring at the grate. These tests give considerable support to those whose tendency in firebox design is toward larger grates and firebox volume that affords ample room for combustion.

YELLOW AS A COLOR FOR DISTANT SIGNALS.

N. Y., N. H. & H. R. R.

For a number of years signal engineers in this country have been seeking for a solution of the problem of satisfactory colors for night signals. There are many arguments in favor of changing present common practice of using red for "stop" and white for "all clear," and it is not necessary to record these further than to note that a white signal light may be mistaken for a stray light that may be adjacent to but has nothing to do with the railroad. Also where white is used for a clear signal a broken glass in a stop signal casting may give a misleading indication and cause a wreck.

The problem has been how to use red for "stop" and green for "all clear" without inconsistency, confusion or uncertainty in the indications of home and distant signals. There is no trouble in using red and green for the indications of a home signal, but a difficulty arises at once with the distant signal owing to the fact that it is not a positive stop signal. Its indication when horizontal, therefore, must be different from that of the home signal, lest we adopt the English practice. The solution has been sought by illuminating the semaphore blade, doing away with the present lights altogether, and this, while very desirable, has not yet been brought to a working success. Efforts have also been made to discover a third color that, while differing from red and green, will be distinctive enough to avoid the danger of being mistaken for a stray light, which will be adapted for use in a distant signal when in the horizontal position.

It has been suggested that white and red should be ex-

changed and white should be used as a stop signal, which would overcome the trouble with broken glasses, but the proposition is too radical to find acceptance even if the cost of changing all switch and train lights was not an obstacle. What is known as the Chicago & Northwestern plan, developed by Mr. E. C. Carter, principal assistant engineer of that road, employs red and green for the home signal and a combination of red and green from one lamp with double lights for the distant signal. In this system the semaphore casting is arranged to give a green light for the "off" position of the distant signal and a red and a green light side by side (from the same lamp) for the horizontal position. This plan has been adopted on the Chicago & Northwestern and has worked very satisfactorily for a number of years, but while it seems to work well this has not put an end to the search for a third color.

Amber and yellow have been repeatedly suggested and have been the subject of a number of experiments, but until very lately they have never been adopted in regular practice, so far as we know, on any road. Several years ago Mr. C. H. Quereau, now Master Mechanic, Denver & Rio Grande R. R., made a series of experiments in this direction for the American Railway Association, and the opinion of that organization was expressed as follows:

"Amber, or yellow, is a combination of red and green. The glasses of this color give a bright signal which can be seen as plainly as either red or green at any distance; but when the color is deep it might be easily taken for red, and when not so deep it could not be definitely distinguished from a white light."

Here the Association left the third color, probably because it was too radical a change to be brought about through a recommendation. The only objection raised to amber or yellow by the association is one of its best recommendations, because if a distant signal using this color for the horizontal indication should be mistaken for white it would indicate a broken glass, which means stop, and if mistaken for red it also means stop. Mr. Quereau found the amber lights that he used clearly distinguishable through long distances, the distinction being stronger at from 1,000 to 1,200 feet than from greater distances. The earlier experiments using "amber or yellow" were generally tried with a reddish yellow, and great difficulties were encountered in securing correct and uniform colors of glass.

Amber or reddish yellow has been discarded altogether, and since 1895 very little has been heard of it. Recent experiments on the New York, New Haven & Hartford have revived interest in this subject, and we recently learned that the semaphore castings for distant signals on that road were being refitted with a view of using what is known as Nels yellow. The change has now been made upon the ten divisions of the Eastern District, and the distant signal arms are now painted yellow, the lights at night being green for "all clear," and yellow for the horizontal position. The matter of lights was thoroughly investigated as a result of the collision at Whittenton Junction on this road Sept. 9 last. This accident was caused by an engineer, who mistook a white lantern on a street crossing gate for a clear signal.

The color of the glass has been carefully studied, and by experiment a satisfactory shade has been found. It is a yellow, not "amber," and not deep enough to be mistaken for a stop signal. The investigation did not end with the color, however, but included the finish of the glass, with a view of giving a distinctive character as well as color to the light. To this end the surface of the glass was formed into irregular corrugations to diffuse the light and give the effect of a "disc instead of a flood of light."

This system is a modification of the English and also a modification of the usual practice in this country. It employs yellow where the English use red in the distant signal. Differences of opinion are held as to the real function of the

distant signal, the view taken on this road being that it is merely a repeater for the home signal, and that it gives no rights of itself. The clear distant signal is green, and it is held that no trouble can arise by an absence of distinction between the home and distant signals when clear, and when in the horizontal position the distant signal will give an indication that differs from all others, and one that indicates at once that it is a distant signal and that a home signal in stop position is not far off. The new color might be called white, or it might be mistaken for white without danger because a white signal would indicate "stop," but even if mistaken for white at a distance a nearer approach would make it clear.

With this system the indications will be as follows: Home signal in horizontal position, red; home signal in "off" position, green; distant signal in horizontal position, yellow, and distant signal in off position, green. The lights are said to be very satisfactory to the engineers, and this is enough to say of the success of the change.

Our opinion on the subject of a third color of the order of yellow was expressed in the Proceedings of the Western Railway Club, March, 1895, page 295.

Since these paragraphs were written we have received a communication from Mr. C. Peter Clark, General Superintendent, Eastern District, N. Y., N. H. & H. R. R., from which the following clear statement is taken:

"When the necessity for a distinctive distant signal color was recognized there were only blue and yellow to consider. The similarity of the blue to green, as well as the admitted weakness of the blue light obtained from an oil flame, at once reduced the problem to yellow. The first experiment was made with one of the old-fashioned so-called amber lenses, used on some roads years ago and gradually given up because of the lack of character necessary to distinguish it from a poor white light. The objection had not been removed by the long rest. An assortment of all available commercial yellows in the market was obtained and a series of tests made. While sufficient encouragement to continue the experiments was obtained, nothing satisfactory was found. Experiments covering several months continued. Three lots of glass were specially made, the last of which seems in every way to fill the requirements of the case. The standard adopted is one-fourth of an inch thick, tough, with smooth surface upon one side and studied irregularity upon the other, which gives the light a distinctive character as well as color. The spectacle glass is made at the same time to appear yellow and luminous, instead of simply transmitting a yellow light, which would more nearly resemble a white light under fog and smoke conditions. Until recently a persistent effort of the yellow or orange colors to disclose a reddish suggestion at a distance has been apparent. Although this is in no way objectionable, being on the side of safety—and toward the English practice—a yellow that does not change its appearance is clearly preferable. The spectroscope clearly shows in light passed through the adopted standard yellow glass a mixture of red, yellow and green rays, which, however, blend into a rich, warm yellow for a distance of one-half to three-fourths of a mile. Beyond this the feebler green rays have apparently been exhausted, leaving the red out of proportion. By cutting a smooth lens, 2½ inches in diameter, in the centre of the disc and rendering this part free from the prismatic effect of the irregular surface which appears to be necessary to give the light desirable character, a sufficient amount of the combination yellow is transmitted to a distance of two miles without the objectionable suggestion of red; at the same time the intensity and strength of the light as a signal is clearly increased. While the chemical ingredients of the glass are not disclosed, assurance is given by the manufacturer, Mr. John C. Baird, of Boston, that they are of a metallic base, and free from the objection formerly quoted against yellows because of their vegetable coloring and tendency to fade under the continued effect of the sun and heat from the lantern."

NOTES.

The passage of the Navy Personnel Bill gives the rank of rear admiral to George W. Melville, M. T. Endicott and Philip Hichborn.

The Baldwin Locomotive Works have received an order for 20 locomotives for the Great Northern of England. The fact is causing a great deal of comment abroad. The original order for 10 engines for the Midland has twice been duplicated, so that this firm has 30 to build for that road.

The North Eastern Railway, England, is building a number of ten-wheel passenger locomotives, the first of this type to be used in England. The cylinders are to be 20 by 26 inches and the drivers 73½ inches, and it is stated that the boilers and fireboxes will be large.

The Pennsylvania Railroad Annual Report for 1898 shows a gain of 5,239,340 tons of freight on lines east of Pittsburgh and Erie over last year and a gain of 7,600,000 tons east of these points. The average rate per ton mile has fallen from 0.536 cent in 1897 to 0.499 in 1898. The average expense of transportation per ton mile was 5.355 cent. The net earnings for east and west decreased \$676,914 from last year, while the Western lines showed a net gain of \$1,880,744.

"Compressed Air and Its Applications," the topic for discussion at a recent meeting of the Franklin Institute, was opened by Mr. W. L. Saunders in a paper giving a historical sketch beginning at the time of Hero of Alexandria and including a resume of present applications. In the discussion it was stated that 30,000 air compressors were now in use in this country alone for air brakes, and the fact was developed that it was a positive disadvantage to separate the moisture from air to be reheated, as the greater specific heat of the particles of water enables the air to be heated much more rapidly.

The large orders for locomotives booked at the present time presage a season of unusual prosperity for American locomotive builders. Recent orders from the Trans-Siberian call for 81 engines. Sweden orders 20. The French State Railways 10. Egypt 15, and the Midland Railway of England 30. The exceptional equipment and facilities of the American locomotive builder facilitates rapid work, and therefore early deliveries of their product, which is one of the prime reasons why these foreign orders come here. The steady growth of the export of locomotives is shown by the following output: 1896, 312; 1897, 348; 1898, 580. At this rate of increase the foreign trade will soon equal home orders.

Mr. John Birkinbine, member A. S. M. E. and president of Franklin Institute, has formulated plans for taking 5 per cent. of the volume of water rushing down through the gorge at Niagara Falls and thus obtain 35,000 electrical horse power from the unharnessed forces now going to waste at the rapids, where there is a speed of about twenty-two miles an hour. It is proposed to take the above volume of water through a canal, along the foot of the gorge and realize on the 45 foot head of water between the whirlpool and the bridge above. This, according to the estimates, can be done at a cost of about \$2,000,000. The canal, when made, is to pass down the gorge between the tracks of the gorge railroad and the precipitous bank, while the power house will be placed at the bend in the river, just opposite the whirlpool. The canal will have a length of 5,300 feet and width of 100 feet, taking water below the bridges and will receive the 10,500 cubic feet of water per second through openings pierced in solid masonry at the head of the canal. This scheme is estimated to cost less to develop than a plant of like power, installed so as to use the direct head of the falls.

FOUR-CYLINDER COMPOUNDS IN FRANCE.

Some valuable records of the performance of French locomotives have been taken during the past year by Mr. Charles Rous-Marten, a complete account of which is to be found in a series of articles in "The Engineer" of London. The chief interest centers in the data on speeds and acceleration taken on trains hauled by the four-cylinder compounds, which have made excellent records, particularly on the Chemin de fer du Nord. While the trains, compared with ours, are light, this road runs a remarkable number of fast ones. Of a list of 24 at speeds of from 50 miles per hour upward, and distances of 50 to 104 miles, seven run faster than 55 miles per hour from start to finish of the trips, and there are many trains averaging from 47 to 49 miles per hour. These figures do not deduct time for stops. One train, between Paris and St. Quentin, 95¼ miles, is scheduled in 102 minutes, or 56.3 miles per hour without a stop. This is the Paris-St. Petersburg express.

Mr. Rous-Marten describes a large number of different fast trains, the speeds of which were taken by the aid of a dynamometer car, and one of these is selected because of the remarkable acceleration that was shown. The regulations limit maximum speeds to 74.4 miles per hour in ordinary express service and on special occasions this may be extended to 77.5 miles per hour, but no faster running is at any time permitted. The train consisted of a corridor saloon, a dining car, a baggage car, an ordinary car and the dynamometer car. Including weights of passengers, estimated, and baggage, the load, exclusive of the engine, was 128 tons of 2,000 pounds. Leaving out of this account a number of interesting features, we note that: "After a cautious start, speed was so rapidly attained that in two miles we were going 60 miles an hour, in three miles 70, and in four miles 71.3, at which pace we started the ascent of the long bank of 1 in 200, which extends continuously for 13 miles, with only the slight breaks of the short level stretches through stations." The speed was sustained for some distance up the grade, and after dropping at one point to 65.4 miles, it recovered to 69, and stood at 68 miles per hour, and was increasing when the summit was reached. This, Mr. Rous-Marten points out, was an average speed of 67 miles per hour up the grade and was exactly the maximum average start to stop speed of any run during the Aberdeen race, including up and down hill and level running.

Another good record was made on a grade of 1 in 333, ten miles long. The initial speed at the base was 40 miles per hour and it rose uniformly until it reached 70 miles per hour at the summit. The entire run of 95¼ miles, from start to stop, was made in 91 minutes 52 seconds. Deducting 6 minutes 41 seconds for slowdowns, the running record was 67.4 miles per hour from start to stop. It will be remembered that the Atlantic City Flyer of the Philadelphia and Reading made 55½ miles at an average speed of 70.8 miles per hour, as recorded in our issue of October, 1898, page 341, but the French engineers are limited in their maximum speed to 77.5 miles per hour, which makes this a very fine showing for the engines. The fastest mile in the Atlantic City run was made at the rate of 84.21 miles per hour.

The engine making this run weighed 113,000 pounds in working order. The heating surface was 1,890 square feet; the grate area 24 square feet. The high pressure cylinders are outside and the low pressure cylinders inside the frames, the high pressure being 13.4 inches, and the low pressure, 20.9-inch by 25.2-inch stroke. The driving wheels are 83¼ in diameter, and the engine is of the 8-wheel type. The outside cylinders connect to the rear driving wheels, while the inside, or low pressure, cylinders drive the forward pair by means of a crank axle. The boiler pressure is 214 pounds. On the Eastern Railway this is exceeded, 227 pounds being used.

Mr. Rous-Marten acknowledges that the performances of

the French engines surpass the best that he has seen in England, and frankly admits that the French engines are more powerful than any in England. We are not so much interested in this fact, as we are in the large number, between 300 and 400 four-cylinder compounds of the type under discussion, built on the principle introduced by Mr. de Glehn ten years ago, and now running in Continental Europe. The same principles are embodied in the engines of the Nord Railway. In a letter to Mr. Rous-Marten, published in "The Engineer," Mr. de Glehn gives his reasons for designing this type, which may be summarized as follows:

This type was selected chiefly because of the limit imposed upon the weight. The compound type uses steam more eco-

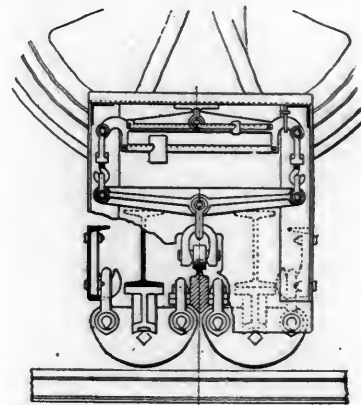
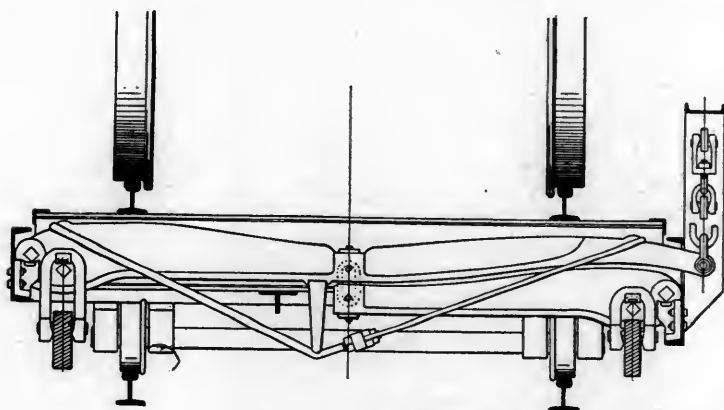
SCALES FOR WEIGHING LOCOMOTIVES. BALDWIN LOCOMOTIVE WORKS.

Although rigid restrictions are placed upon the weights of locomotives upon their driving wheels and the loads are calculated sometimes, as far as to include the weight of rivet heads in the boiler, these weights in the finished locomotive are generally guessed at. At least the methods used for obtaining the weights are often not more accurate than guessing, and one railroad in this country has weighed locomotives for thirty years without a fixed rule as to the amount of water in the boiler.

The Baldwin Locomotive Works' method of weighing is



A Locomotive Mounted on the Scales.



Scales for Weighing Locomotives.
Baldwin Locomotive Works.

nomically and therefore weighs less, per horse-power developed, than a simple engine of the same capacity. This is equivalent to saying that larger boiler power may be had without increasing the weight of the boiler. Mr. de Glehn believes that for a given total weight a four-cylinder compound may be made 15 or 20 per cent. more powerful than a simple engine. He finds that the work of the engine is better distributed over the working parts and that with more wearing surfaces there is less wear than with a two-cylinder engine, notwithstanding the increased mechanical complication. He finds that the repairs are less than with simple engines. The four-cylinder compounds are balanced, which has an important bearing upon the cost of repairs, because the engines do not shake themselves to pieces. That they have remarkable accelerating power is illustrated in the figures quoted from Mr. Rous-Marten's records.

shown in the accompanying engravings. The photograph illustrates the method of obtaining the distributed weight by mounting the locomotive upon small portable scales carried upon wheels, so that they may be moved under and support the wheels of the locomotive. The practice of these builders is to weigh locomotives with full tank and three gages of water in the boiler. The weights given for the one shown are: Front truck, 11,850 pounds; first pair of drivers, 21,800; second pair of drivers, 22,955; first pair of rear truck wheels, 10,000; second pair of rear truck wheels, 10,500; total weight of engine, in working order, 77,105 pounds.

The weighing machines are very compact. They are about 7 feet 6 inches long by 2 feet 6 inches wide and have a capacity of 60,000 pounds each. They are carried on frames of rolled steel shape and are so made as to avoid all detachable parts, and this applies even to the scale weights.

STEEL BOILER TUBES.

The attention of railroad mechanical officers has long been occupied with the relative value of steel and iron for boiler tubes, and the question seems to be pressing with as much vigor, and also is as far from settlement as at any time since steel came to claim a share of consideration for this purpose. One of the most serious drawbacks to the use of steel tubes was the difficulty of welding when necessary to piece the ends after removal from a boiler. This obstacle was removed by the production of a material low in carbon, but there is still an objectionable feature in steel tubes that may or may not be eliminated by attention to its chemical composition, namely, that of persistent leakage at the flue sheet after a short period of service, and this fact no doubt had a strong bearing on the report of the Master Mechanics' Committee on the best material for tubes, which was submitted in 1895, although pitting was given equal prominence as an objectionable quality of steel at that time.

The importance of the failure of steel tubes to remain tight, in its bearing on a choice of material, is plainly something to be reckoned with by the maker of those tubes, as the subjoined letter from Mr. William H. Lewis, Master Mechanic of the Morris & Essex Division of the Delaware, Lackawanna & Western, gives evidence as follows:

"I have used steel tubes for locomotives on this division from 1885 to 1894 with the following results: They work all right for a few months after being put in, after that time they give trouble, losing the soft quality they had when new, and they also toughen like rubber, so much so that when rolled again they follow the tool around and do not tighten in the sheet enough to make a good joint, consequently, they soon commence to leak again. I have, therefore, discontinued their use. There is no doubt in my mind that steel tubes are better adapted for use in marine boilers than in locomotives, because of expansion and contraction. Fires in ocean steamers are drawn perhaps twice a month on an average, whereas, in locomotives they have a chance to expand and contract about five or six times a day."

The coefficient of expansion of steel and iron per degree Fah., per unit of length, are exactly the same, and the reason why iron should remain tight under certain stresses due to alternate cooling and heating, while steel will not, furnishes proof that the elements of the latter material require revision to cover the conditions. The serious problems are the prevention of pitting and the trouble in securing tight joints under the severe conditions of locomotive boiler service, which are entirely different from those of marine practice, one of the greatest differences being in the water and its effect upon the metal.

LEAKY AIR BRAKE TRAIN PIPES.

The efficiency of the air brake is no doubt due to the constant vigilance of those directly interested in its performance, by this is meant not those who use but those who maintain it. This is shown by the interest in air brake matters taken by railway club members, and their conscientious committee work. Messrs. F. B. Farmer, G. R. Parker and J. Casey of the Northwest Railroad Club made a report at the January meeting on the waste of air from freight train pipes due to leaks and improper maintenance, with the resulting overworking of the air pump to make the losses good with a consequent waste fuel in compressing air to overcome piping defects.

The committee made it clear that the air brake was at its best only when the proper pressure was maintained in the system, and showed how the benefits of the brakes in safe movements and expeditious handling of trains were sacrificed when from any weakness in the system this pressure could not be maintained. Considerable attention was given to the work required of air pumps other than supplying air to the brake system. Among these was mentioned air for sanding the track.

operating bell ringers, flangers, blow-off cocks, and also the control of the separate exhaust of one type of compound engine. These drains on the pump were thought to be of not much consequence, however, except in case of the sanding devices and the bell ringer, ranking in importance in the order named.

There was thought to be more leakage in the train pipe than could be well supplied by the pump, without burdening it with the extra work. Much complaint arose from the leaks caused by the escape of air past the coupling packing rings, also those at pipe unions and at the triple valves. In the case of a test made upon a hose coupling by the committee, a leak which was of apparently little account amounted to 133 cubic inches of air per minute at a pressure of 45 pounds per square inch, and it became 210 cubic inches at 70 pounds, and 294 cubic inches at 110 pounds. These figures give a good idea of the additional work imposed on a pump through a leaky pipe system, even when the leaks are thought to be insignificant. It was recommended that large pumps be used for locomotives and also for compressors at terminal testing plants for the reason that best economy could be expected only by having an ample supply to cover all possible conditions.

PROGRESS IN SAFETY APPLIANCES.

The progress made by the railroads in the application of safety appliances to rolling equipment is shown in a recent statement made by the Interstate Commerce Commission. An extension of two years' time was allowed to 294 petitioning carriers in which to equip their freight cars and locomotives with safety appliances, and these report 1,217,636 freight cars and 33,624 locomotives owned on Dec. 1, 1898. There are 117,176 freight cars reported equipped with automatic couplers and 254 reported equipped with train brakes during the six months ending Dec. 1, 1898, which makes a total of 927,823, or 76 per cent., of the freight cars equipped with automatic couplers and 619,252, or 51 per cent., equipped train brakes, up to Dec. 1, 1898. Of the 33,624 locomotives owned on Dec. 1, 1898, there are 30,812, or 92 per cent., which are equipped with driving-wheel brakes. Out of a total of 1,217,636 freight cars there are 289,807, or 24 per cent., that are still not equipped with automatic couplers, and 598,384, or 49 per cent., that are not equipped with train brakes. Of the locomotives there are 2,812, or 8 per cent., that were equipped with driving-wheel brakes on Dec. 1, 1898. There were 651 cars destroyed and 600 sold of the total number reported equipped with automatic couplers. Of the total number of cars equipped with train brakes since Jan. 1, 1898, there were 138 destroyed and 600 sold.

AMERICAN LOCOMOTIVES IN ENGLAND.

The Midland Railway of England is so well organized and equipped as to cause controversy in that country concerning the necessity for the recent orders for American locomotives, and the chairman of the road furnished an explanation in a recent speech, which was reported by English papers, in abstract, as follows:

"It would be seen that the directors had ordered some locomotives in America, and, as this was a new departure, no doubt some information on the subject would be of interest. He would much prefer to order goods of any kind that were of home manufacture, and he might say that the question of cost was not one that entered into the calculations of the directors when asking for tenders from over the water. The increase in their train mileage had been very large lately, being in 1898 considerably over 2,000,000 miles; and it was obvious, therefore, that additional engines must be purchased. For years past their locomotive superintendent (Mr. Johnson) had impressed upon them that they worked their engines too hard. He believed the ideal position, according to Mr. Johnson, would be that they should have 75 per cent. in steam; but 90 per cent. had been much nearer their figure, so that there was no margin. They had now on order in this country 170 engines. They commenced ordering in December, 1897, and the first delivery should have been made in July of that year, and they should

have been receiving a number in each month, which would have made up a delivery to the present time of 48 engines. The company had not received one of these. The last order given was in November of last year, for 20 engines, at an extravagant price, and the makers did not even promise delivery of one for 15 months, the order to be completed in May, 1900. Locomotives were a necessity to the company; they must have them, and so the directors determined to ask for tenders from America. They asked for tenders for 10 engines each from two firms—the Baldwins and Schenectadys—and they received offers to deliver in the one case within 10 weeks from the date of the receipt of all necessary information for construction, and in the other case shipment from America was promised for March next. This offer was made in December, so that, while the directors could not get an engine made in England and delivered in Derby in less than a year and a quarter, they could get 20 from America in four months. The engines would be of the American type, with certain alterations which Mr. Johnson considered desirable. They would be of the same power as the Midland engines, and it would certainly be interesting to watch their performance, as Mr. Johnson—and he hoped all his staff—intended that they should have fair play in every particular."

SAVING BY USE OF COMPRESSED AIR IN RAILROAD SHOPS.

We have come to be very familiar with the diverse uses to which compressed air is applicable in shop operations, but the comparative cost of this convenient agent with methods it displaces has not been available prior to the reading of a paper having the above title before the Western Railway Club by Mr. B. Haskell, Superintendent of Motive of the Chicago & West Michigan. In the case of loading wheels by an 8-inch air hoist, a car is loaded at a labor cost of 15 cents, while the old manual style of loading by means of a long incline to the floor level of the car cost for labor \$1.02, giving a saving of 87 cents per car. The same hoist is also used for loading and unloading, reducing the cost of handling material 50 per cent.

By the use of pneumatic hammers the cost of beading a set of flues is reduced from \$2.50 for hand work to 75 cents by air. The cost of tapping staybolt holes and screwing in staybolts by air motors has been reduced from \$45.90 for hand work to \$15.30 on a new firebox. A saving of \$13.16 per firebox is effected by drilling the ends of staybolts with the motor at a cost of \$4.62, while by the old way the cost would be \$17.78. A set of tires is removed for 50 cents and replaced for 87.5 cents, the figures in this case, however, do not include labor. In the preparation of a new locomotive for priming coat of paint the surface is brought to condition by the air and sand blast instead of by hand abrading, the latter process requiring about 35 man-hours at a cost of \$3.50, while the sand blast requires two man-hours at 14 cents an hour and two man-hours at 10 cents an hour, or 48 cents, a saving of \$3.02 by the sand blast.

The sand blast is also used in frosting deck glass for passenger cars, the cost per glass for labor and material being 12 cents, or a saving of 60 cents. The cleaning of coaches by air is done at a cost of 87 cents per car, a wide, flat nozzle being used. One man only is required to move cushions and seat backs, blow all dust out of them and the interior of the car and complete the cleaning of the car ready for the road in three hours, while beating by the old way required ten hours. The painting of cars by the paint spraying machine has reduced the cost for labor approximately 92 per cent. The same spraying machine is used for whitewashing, which is done on plain surfaces at a cost of 1 cent a square yard for labor and material. A saving of 67 cents per car in applying two coats to a 34-foot box car is shown by the paint spraying machine over hand work. The following statement gives the itemized cost for both methods:

	By Machine.	
Labor, 40 minutes, 12.5 cts.....	\$0.08	
Lettering, 3 hrs., 12.5 cts.....	37.5	
Five gals. paint, 60 cts.....	3.00	
Two lbs. white lead, 6 cts.....	.12	
	\$3 57	
	By Hand.	
Labor, 6 hrs., 12.5 cts.....	\$0.75	
Lettering, 3 hrs., 12.5 cts.....	37.5	
Five gals. paint, 60 cts.....	3.00	
Two lbs. white lead, 6 cts.....	.12	
	\$4.24	

The savings effected by pneumatic tools have brought about a revolution in many operations, for example as noted in the paper, all operations on firebox work. With the pneumatic hammer it costs 25 cents to caulk 100 flues; hand work costs \$1.05, or a saving of 80 cents per hundred flues for airwork. In the matter of staybolt holes, one man at 15 cents an hour will tap out by hand from 75 to 80 holes in ten hours, whereas, with the machine he can do 175 to 200 holes in the same time, and putting in staybolts, one man at 15 cents an hour will put in by hand from 175 to 200 bolts in ten hours, while for a like period the air tool will put in from 300 to 400.

These brief abstracts will doubtless have more weight with intending purchasers of air tools than would the claims of builders of the tools. In any event, the figures are interesting, as showing how the cost of some shop work operations are affected by the use of modern air appliances, and they carry their own moral.

Some very rapid work in car erection was done not long ago at the Water-Valley shops of the Illinois Central. Master Mechanic Curley, having some 50,000 pound coal cars to build, instructed his foreman, Mr. F. W. Taylor, to take six men and put up one car, including air-brake equipment, and note the time occupied on the work. The six men completed it in exactly three hours and fifty minutes, including one coat of paint. It should be understood that the trucks and as far as possible all other work was ready for putting up and assembling when the construction was begun. This work was undertaken to vindicate Mr. Curley, who had put up two 40,000 pound cars in 1883 with the same force per car, in eight hours, but without air brake, which story was always doubted. He is supported by a statement which we have received from Mr. F. W. Brazier, Assistant Superintendent of Motive Power of the road.

The following table of the boiling points of liquified gases at ordinary atmospheric pressure, reprinted from "Engineering," may prove useful as a record:

	Deg. Cent.
Sulphur dioxide	10
Chlorine	33
Ammonia	38
Sulphuretted hydrogen.....	62
Carbon dioxide	78
Nitrous oxide	88
Ethylene	102
Nitric oxide	153
Marsh gas	164
Oxygen	183
Argon	187
Carbon monoxide	190
Air	192
Nitrogen	195
Hydrogen	238

Mr. John S. McCrum died of apoplexy at his home in Kansas City, Mo., March 20, at the age of 61. Mr. McCrum was for many years Superintendent of Motive Power and Machinery of the Kansas City, Fort Scott & Memphis. He began his railroad career as an apprentice to the machinists' trade on the Pennsylvania Railroad in 1854. His railroad experience was a varied one, embracing a service of four years as machinist and engineer in Cuba, besides four and a half years with the United States military roads, and one and one-half years as an engineer on the Kansas Pacific. His connection with the Kansas City, Fort Scott & Memphis began in 1869, and from 1870 to 1895 he was in charge of the machinery department of that road.

The National Electric Car Lighting Company has received orders for car lighting equipment for use on a car on one of the Russian railroads, for an application to an officers car on the Illinois Central, for the private car of Vice-President Crocker of the Central Pacific and for eight postal cars on the Atchison, Topeka & Santa Fe. The last mentioned equipment and the one in Russia have been applied and are now running. The Atchison has a number of cars lighted by this system as has been noted in these columns.

CHILLED WHEELS FOR 100,000 POUND CAPACITY CARS.

It seems eminently fitting that the Carnegie Steel Company should have been the first to experiment on a large scale with steel cars having a carrying capacity of fifty tons, as no company was better qualified to draw up specifications for the material entering into their construction. A glance at the specifications on which bids were finally asked for the 100,000-pound steel hopper cars built for the Pittsburgh, Bessemer & Lake Erie Railroad, shows how thoroughly they entered into a consideration of all the details, and it will be noted that the bidder was left no opportunity to put in inferior material, the maker from whom the various parts would be purchased being definitely specified. The method employed for deciding on the wheels to be used may be taken as an indication of the thoroughness with which the Carnegie Company went into the whole subject, and as typical of the course followed for all the parts entering into the construction of the steel car.

Letters were sent to the leading wheel manufacturers in various parts of the country, stating clearly what was required, and asking that a special design be submitted of the wheel that would in their opinion be the best suited to meet the unusually severe conditions, together with bids for furnishing the number required. The designs were then considered without any reference to the price quoted, but entirely on their merits, and it was pre-eminently a case of "the survival of the fittest." It was an open question whether any cast-iron wheel would stand the repeated and severe heating due to the long continued brake action necessitated in stopping so great a mass, and whether the large proportion of cracked plates resulting would not make the chilled wheel uneconomical, even if the strains did not cause breakages in service.

The New York Car Wheel Works, of Buffalo, N. Y., were among those invited to bid, and they submitted a design for a 33-inch wheel weighing only 50 pounds more than those used under 60,000-pound cars, but made of special qualities of iron from which they had obtained very greatly increased strength. This company took the position that it was undesirable to increase the weight proportionately to the increase in load, as that tended to set up shrinkage strains in the plates, which would only increase the likelihood of their cracking, but they recommended obtaining the requisite strength by using good qualities of iron and submitted tests that they had made and records of service that had been obtained from their special wheels under locomotives to prove that the increase in strength was there. Briefly, this increase in strength may be best shown by comparing the breaking strains of test bars made from both mixtures one inch square and twelve inches between supports in transverse strength. With the best foundry practice and ordinary mixtures, a bar of this dimension would show a transverse strength of from 2,600 to 3,000 pounds, but by the use of their special mixtures these manufacturers were able to obtain from 3,500 to 3,800 pounds, an increase of about 33 per cent. The New York Car Wheel Works T. M. Special wheel was specified under the first 600 100,000 pounds capacity steel cars built for the Pittsburgh, Bessemer & Lake Erie Railroad, and later under the additional 400.

It was further specified that the wheels should be "machined" on the tread, i. e., rotated between rapidly revolving emery wheels touching the tread at two opposite points that not only took off any slight irregularities, but left the wheel truly round, and this was also in accordance with the wheel company's recommendation, as the absolute roundness of the wheel reduces the likelihood of "skidding" to a minimum.

Two things may have had a decided bearing on the decisions to use this wheel, and these were the fact that the manufacturers had been making an especial study of the production of wheels of high grade for particularly severe service, and the other that owing to the system of comparative tests under which their wheels are made, there was an absolute certainty that no wheel could be shipped that fell below a certain standard determined upon beforehand. By means of these

tests, the transverse strength of the metal and the depth and hardness of the chill are accurately determined before the wheel leaves the foundry.

The specifications under which the wheels were made called for the Master Car Builder's test with a minimum of fifteen blows, one wheel being selected at random by the inspector out of each one hundred as representing this lot. Other tests that were to be made at the discretion of the inspector were the Pennsylvania Thermal test and the Austro-Hungarian test. Below we give the actual results obtained, which are certified to by the Carnegie inspector.

Chilled Wheels for 100,000 Lbs. Capacity.

Number of Blows of 140-Lbs. Weight, Dropping from a Height of 12 Ft., Required to Break 650 Lbs. Special Wheels Furnished to the P., B. & L. E. R. R. for 100,000 Lbs. Capacity Cars.

Date tested.	Blows to crack.	Blows to break.	Date tested.	Blows to crack.	Blows to break.
May 17	61	94	Sept. 17	61	112
" 18	73	85	" 18	63	85
" 19	54	91	" 21	39	71
" 20	50	100	" 21	32	55
" 21	56	111	" 22	23	111
" 22	43	76	" 22	55	123
" 24	54	78	" 23	37	57
" 25	43	66	" 23	21	85
" 26	48	85	" 24	73	107
" 27	24	50	" 24	40	134
" 28	15	60	" 25	39	108
" 29	26	47	" 29	57	136
June 1	28	33	Oct. 1	45	66
" 2	9	99	" 1	70	182
" 3	18	78	" 1	78	123
" 4	30	74	" 4	35	61
" 5	64	106	" 5	55	111
" 7	34	78	" 5	62	86
" 8	32	45	" 6	60	110
" 9	49	80	" 6	61	88
" 10	55	76	" 7	72	157
" 11	44	106	" 9	86	170
" 12	60	151	" 9	62	81
" 14	68	141	" 11	88	205
" 15	78	92	" 12	34	57
" 16	73	161	" 14	71	120
" 17	44	216	" 14	63	111
" 18	116	182	" 14	60	106
" 19	66	151	" 15	54	114
Sept. 15	77	114	" 16	50	101
" 15	60	89	" 21	30	47
" 17	65	143			

Average of 63 car wheels, 102 blows to break.

On the Master Car Builders' Test ordinary wheels are accepted if they successfully stand five blows.

On looking over this list, in which each wheel represents a lot of one hundred, one is immediately struck not only by the fact that the number of blows that it took to break the wheel far exceeded the specifications, but that in nearly every case as many blows were struck after the wheel was once cracked before it broke, as it took to crack the wheel. In every case but one, the wheel did not even crack until the number of blows specified was passed, and in that one case, the cracked wheel stood ninety additional blows before it broke. No better demonstration could be given of the strength and of the toughness of the iron in the wheels than this gradual failure. The results the wheels are showing in service is quite as remarkable as the tests, as out of the whole 8,000 furnished, which have now been running over a year, as far as can be learned, not one has yet been removed for any cause.

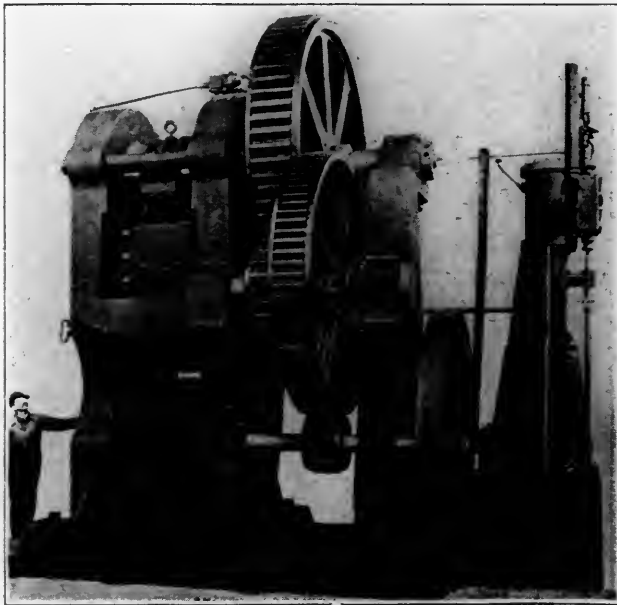
General Manager Underwood, of the Baltimore & Ohio Railroad, has issued the following general notice to station agents and trainmen: "Your especial attention is directed to the treatment of patrons by employees of the company. Complaints have been made from various sources of discourtesy to freight and passenger patrons on the part of our agents, or their representatives, at several of our stations, and also inattention of conductors and brakemen to properly care for the comfort of passengers. There should be no cause for such complaints. It is a part of your duty to see that our patrons are treated at all times with politeness and courtesy, not only by yourself, but by employees under your charge. One of the valuable assets of a railroad company is uniform politeness and courtesy from all of its employees to its patrons, and this capital must not be encroached upon. It is proper for you to understand that advancement does not depend wholly on your efficiency, but in other directions also, and will be measured in a great degree by the treatment accorded to patrons."

MONSTER BLOOM SHEAR.

The Long & Alstatter Co.

The Lorain Steel Company, of Lorain, Ohio, have recently received a very large shearing machine, built especially for them by the Long & Alstatter Company, of Hamilton, Ohio. The engraving shows the appearance of the machine and an idea of its proportions is given by comparison with the height of the man standing beside it.

The work to be done is in cutting steel blooms, and it will cut these as large as 10 by 10 inches in section, or 100 square inches of metal at a single stroke. This shear is located beside another, which has been at work for several years, the two being placed close together to permit of being attended by one man. The machine is 21 feet high, its total weight is about 250,000 pounds, and each housing weighs more than



A Large Bloom Shear.

54,000 pounds. The steel castings used weigh about 35,000 pounds, while the cam shaft which operates the slide weighs more than 10,000 pounds. These figures give an idea of the size of the shear. The stroke is 10½ inches.

The cylinder is 14 by 18 inches. Tilting of the bloom, while being cut, is prevented by an automatic and adjustable attachment for holding it down and a gage determines the length for cutting. The shear and outboard housing are mounted upon a heavy bed plate with octagonal ways, upon which they may slide for convenience in making repairs, and these also serve the purpose of keeping the parts of the machine in line. We are indebted to the Long & Alstatter Company for the photograph and particulars.

STREET CAR BRAKES.

The announcement of the prospective tests of street car brakes to be conducted under the direction of the New York State Railroad Commission has awakened a great deal of interest in this subject, and our attention is called to the merits of a brake that has been in successful and apparently entirely satisfactory use for the past four years on the lines of the Metropolitan Street Railway in New York. We refer to the Sterling Safety Brake and desire to do justice to it in view of the sweeping statement printed on page 93 of our March issue. The Sterling Supply & Manufacturing Co., 141 East Twenty-fifth street, New York, the makers are prepared to show that

the record on the Metropolitan has not been surpassed anywhere.

The device is an improvement upon the old style of hand brake, it is operated by hand and consists of a pinion, operated by the brake shaft or spindle, which meshes into a gear and sprocket wheel cast in one. The sprocket wheel carries a double chain connection—the object of the double chain being that, in the event of one chain breaking, the other remains operative. By the gear and pinion added power is obtained. The ratio of gearing of the pinion to the gear is 2 to 5. These parts are contained within a housing, which is placed directly under the platform of the car and the entire mechanism takes up a very small space.

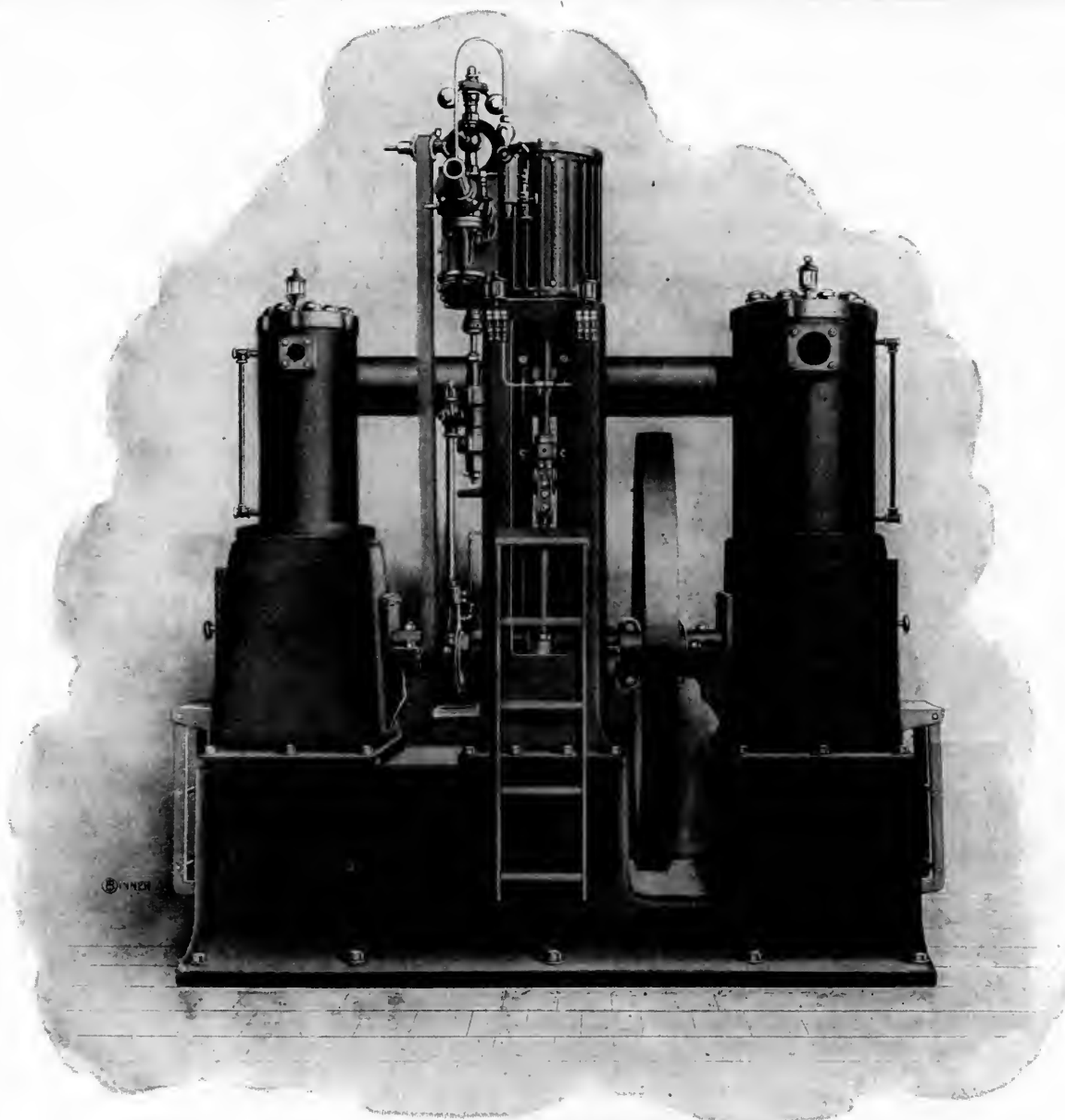
The advantages urged in favor of this system are that it is controlled directly by the motor man and does not depend in any way upon automatic apparatus, it is designed to reduce wear to the minimum by placing the chains around a sprocket wheel that is large enough to distribute the load over a proper length of chain. It is held to be better than brakes using auxiliary power and is sufficiently rapid in action and much more certain owing to the danger of failures with auxiliary power, especially where stops must often be made quickly and frequently. The cost of auxiliary power brakes is greater, and while no claim is made that the Sterling brake is advantageous for high speed suburban traffic it has satisfactory claims for attention for its sphere, city railroad work and for braking cars running singly.

SAFETY CHAINS FOR PASSENGER CARS.

A committee comprising Mr. J. M. Holt and Mr. C. F. Thomas, of the Southern Railway, submitted a report on safety chains to the Southern and Southwestern Railway Club at the January meeting. The efforts of the committee were directed to an improvement of the design at present in use, so as to prevent as far as possible the danger of trains parting from weakness of the chain connection, it having been found that the chain and hook adopted by the M. C. B. Association in 1890 could not be depended on to withstand a load of more than 35,000 lbs. These chains were known to be too weak to hold a train together in case of failure of the draw-bar, and the committee devised a safety chain and attachments intended to be reliable under all conditions of service. The safety chain proposed will stand a load of 75,000 lbs. before rupture—the test showed 77,000 lbs.—and after a service of more than a year with the most satisfactory results, they are being applied to the entire passenger equipment of the road. The improvement consist in designing the chain and hook—one link and one hook—with the proper amount of metal in the proper place, which after all is simply correct design. There has long been need for improvement in the strength of this detail, particularly in mountain districts and where reverse curves abound, and this fact seems to have been fully recognized in the work of the committee, for the chain has been designed with the view of either one taking the whole load in the event of the failure of the draw-bars on curves.

MEETING OF THE A. S. M. E. JUNIORS.

A meeting of the junior members of the American Society of Mechanical Engineers was held at the society house on the evening of March 7 for the purpose of effecting an organization for the purpose of holding regular meetings for the presentation of papers and discussions upon them. The idea is an excellent one which should be encouraged, and the younger members should have all necessary assistance in perfecting their plans. The first meeting was not a great success, as far as the proposed organization is concerned, but many of the seniors were attracted by the illustrated lectures by Chief Engineer Gardner C. Sims and Lieutenant W. S. Aldrich, describing the supply ship "Vulcan," and the experiences of that ship off Santiago. The raising and attempted towing of the Spanish ship "Maria Theresa" to the United States were also described. These topics were intensely interesting. The organization of the juniors appears to be promising, although comparatively little was done at the first meeting.



A Steam Driven Shop Air Compressor.
Curtis & Company Manufacturing Company.

A STEAM DRIVEN, SHOP AIR COMPRESSOR.

Curtis & Co. Manufacturing Company.

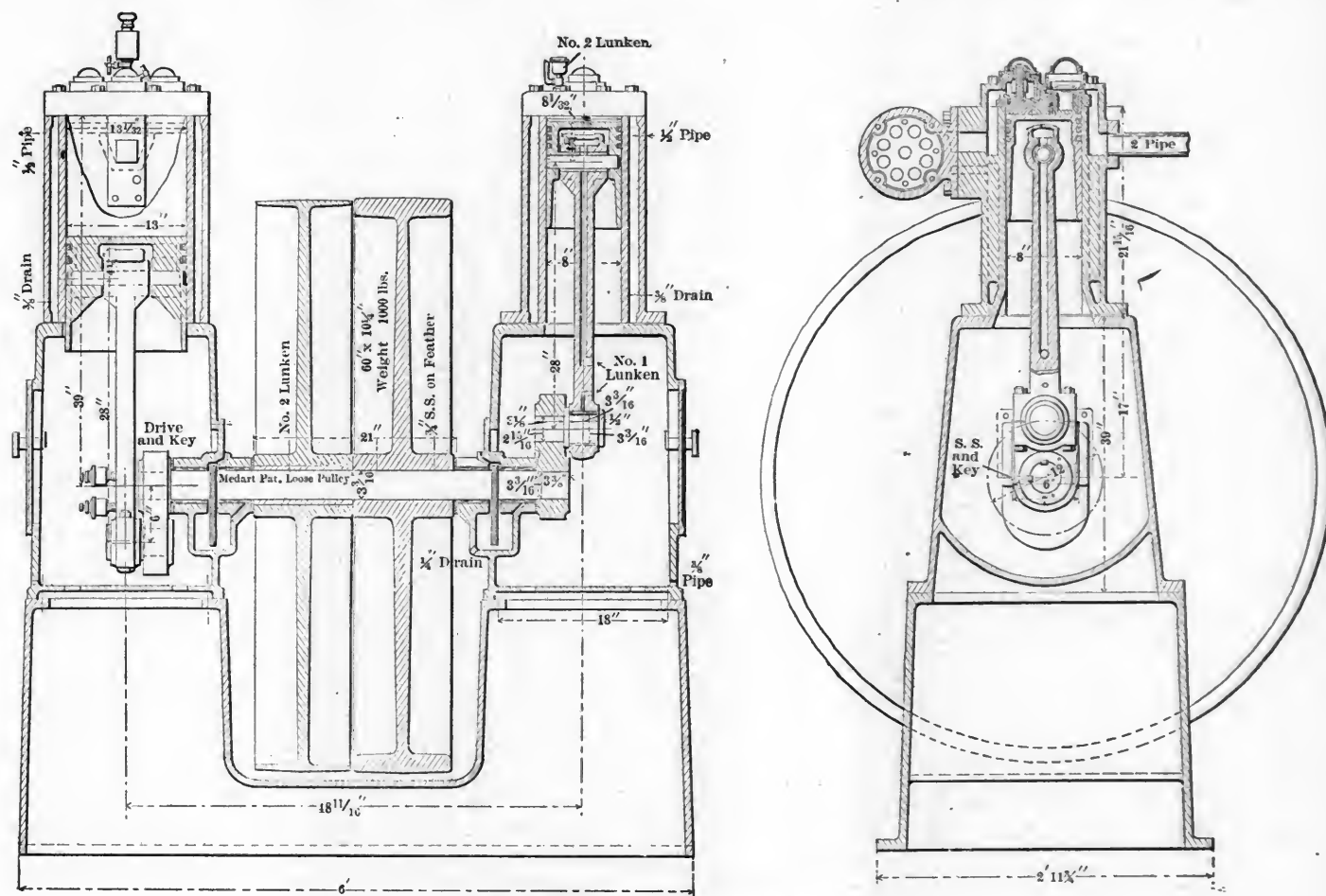
These engravings illustrate an air compressor especially designed for the constant maintenance of a working supply of compressed air in machine shops, boiler shops, foundries and similar places, where it is a growing practice to employ tools and other appliances operated by compressed air. The compressor is steam driven with a direct connected vertical engine. The machine is designed to run continuously, and the engine is controlled by a Gardener throttling governor, with a heavy yoke throttle valve. The governor is ordinarily fitted with a slow-down device, controlled by the air pressure, so that the governor valve is nearly closed when the air pressure in the reservoir reaches the desired point. When the service is very intermittent, a Curtis relief governor is added, so that the machine will not compress when running slowly, thus practically consuming no power except when air is needed.

The sectional engraving shows the front and side of a belt-driven compressor, 13 and 8 by 12 inches; but, as far as the compressor part is concerned, the construction is the same as that of a steam-driven machine, and the engraving shows the machine, with a low-pressure cylinder, 16 inches diameter and

16 inches stroke, the high-pressure cylinder being 10 inches diameter by 16 inches stroke; the cylinders and cylinder heads are thoroughly water jacketed; the compression is in two stages, with a sufficient intercooler between the cylinders, with a large capacity when compared to size of the cylinders, so that air is thoroughly cooled when passing from the high to the low pressure cylinder. The intercooler is filled with thin brass tubes, through which the water circulates. The cooler is designed according to the best practice in marine engine condensers. Both heads provide for expansion, and the bolts which are exposed to the water are of bronze to prevent corrosion. The intercooler is bolted directly to the cylinders. Properly located partitions in the cylinder, water jackets and intercooler compel a thorough circulation of the cooling water. Drain cocks are provided to drain the intercooler and water jackets.

The capacity of this machine, running at 120 revolutions, is 200 cubic feet of free air per minute. The compressor will work easily against 110 pounds pressure.

The size of the steam cylinder is determined by the boiler pressure and the desired air pressure. As will be seen, the compressor is entirely inclosed, but the working parts are easily accessible; by a hinged door at the side, the connecting rods, cranks and main bearings are accessible, and all valves are in the cylinder heads, each valve having its own cap and



A Belt Driven Shop Air Compressor.

Curtis & Company Manufacturing Company.

being independently removable. The location and form of the valves are such as to reduce the clearance to almost nothing. In the half-tone the high-pressure cylinder is nearest the observer, and the air is discharged at the side flange to which the pipe to the reservoir or line is to be attached.

The free air enters at the side flange of the other cylinder through an air pipe, which may lead from the outside of the building. The provision for lubrication of every working part is deserving of notice. There are chain oilers on the main journals, a pressure grease cup takes care of the upper pin and the crank pins dip in oil at each revolution. The oil cups on the engine are filled by an oiling system centering at the centre of the engine, just below the cylinder.

The design of this compressor is quite novel, both cylinders being single acting, which does away with stuffing boxes, and gives a cooling area 80 per cent. greater than a double-acting cylinder, greatly increasing the efficiency.

This machine is self-contained and weighs a little over 13,000 pounds. All parts are very liberal in proportion, insuring stability and durability and admitting of using light foundation. The automatic regulation makes it economical for intermittent work. The engine is simple and strong; it is connected to the compressor with cranks at right angles, causing very smooth running. The parts are easy of access and are not crowded or overloaded with duties and small intricate forms, for complicated details have been avoided.

The machines are equipped with a fly wheel 5 feet 6 inches diameter, weighing 2,000 pounds. The machine base is 8 feet 7½ inches by 4 feet 6 inches; the total height is 11 feet.

Curtis & Co. Manufacturing Company, of St. Louis, Mo., are manufacturers of this and similar machines, both belt and steam driven, in sizes from 25 to 200 cubic feet of free air per minute. They also make a specialty of air hoists and general foundry equipment.

MODOC SOAP FOR CLEANING CARS.

It is an unusual thing to find passenger cars with the bright sheen of the paint shop on them after a few months' service. Cars that are neglected very quickly reach a condition that is irreclaimable, as far as a respectable appearance is concerned, without the aid of varnish, for soap and water applied to a car on which dirt has been allowed to accumulate is one of the worst remedies that can be applied, as it is a deadly enemy to varnish as well as paint. In any event, repeated washings with soap have the effect of dulling the varnish and putting it in a more receptive condition for dirt. Having recently noticed the well-groomed appearance of some coaches of the old standard yellow color, a color that is handsome when clean, but one not well adapted to resist dirt, some inquiries were made of an official touching the method of cleaning. We were informed that they were cleaned every thirty days with Modoc Liquid Car Cleaner at a cost of \$1.25 per car, which low figure is accounted for by the fact that the cars are not allowed to get dirty and are, therefore, easily cleaned.

This liquid cleaner does not clean a dirty car as quickly the first time used as soap and water, for its components are weaker and therefore less harmful to varnish and paint. These cars, when very dirty, are first cleaned with Modoc Powdered Soap and afterwards dressed with the liquid, using no water whatever, leaving the cars as bright and clean as though just out of the shop, and this result, we are informed, is obtained with any color, whether yellow or the standard Pullman. The appearance of these cars justified the claim that there were none finer.

A NEW VERTICAL HOLLOW CHISEL CAR MORTISING MACHINE WITH AUXILIARY BORING ATTACHMENTS.

Builders and repairers of cars, and, in fact, those concerned in any construction where heavy mortising is required, will be specially interested in the new No. 4 Vertical Hollow Chisel Mortiser designed and built by J. A. Fay & Company, 516 to 536 North Front street, Cincinnati, O. This machine is the most powerful and reliable of the kind ever offered to the wood-worker, and is remarkable in containing the essential elements of strength, simplicity, and efficiency, the possession of which are so necessary to satisfactory results in any machine; results that are attained, too, without requiring the work to be laid out or the mortises cleaned. The frame is of the usual solid type built by this company, with a distribution of material looking to lightness and stability, requisite to rigidly support

ing the work securely in place while operated on. The auxiliary boring attachments are located at each side of the machine sufficiently distant from the chisel to allow an adjustment to an angle of 30 degrees in either direction, and they are also provided with a vertical adjustment of 20 inches and a lateral movement of 12 inches. This machine, which is the product of a corps of experts constantly engaged in design of wood working tools, represents the best thought yet put into this form of machine for accurate and rapid work.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

A geodetic observatory is a necessary part of the equipment of an institution giving instruction in geodetic methods of surveying. The plans for the erection of such an observatory near Boston have been under discussion ever since the adoption of what is known as the geodetic option of the course in civil engineering, but it was not until May of 1898 that the observatory became an established fact.

This observatory is intended primarily to be used in giving instruction in the most refined methods of determining Latitude and Longitude, and secondarily to be used in magnetic and gravity observations. A hill in the southeastern part of Middlesex Fells was chosen for the site. Here was found a firm foundation for the most delicate instruments, free from the vibrations caused by railroad and highway traffic and not too far from Boston. There is an unobstructed view of the heavens and the horizon, with the two United States Coast Geodetic Survey triangulation stations, at Blue Hill in Milton and Prospect Hill in Waltham, in plain sight.

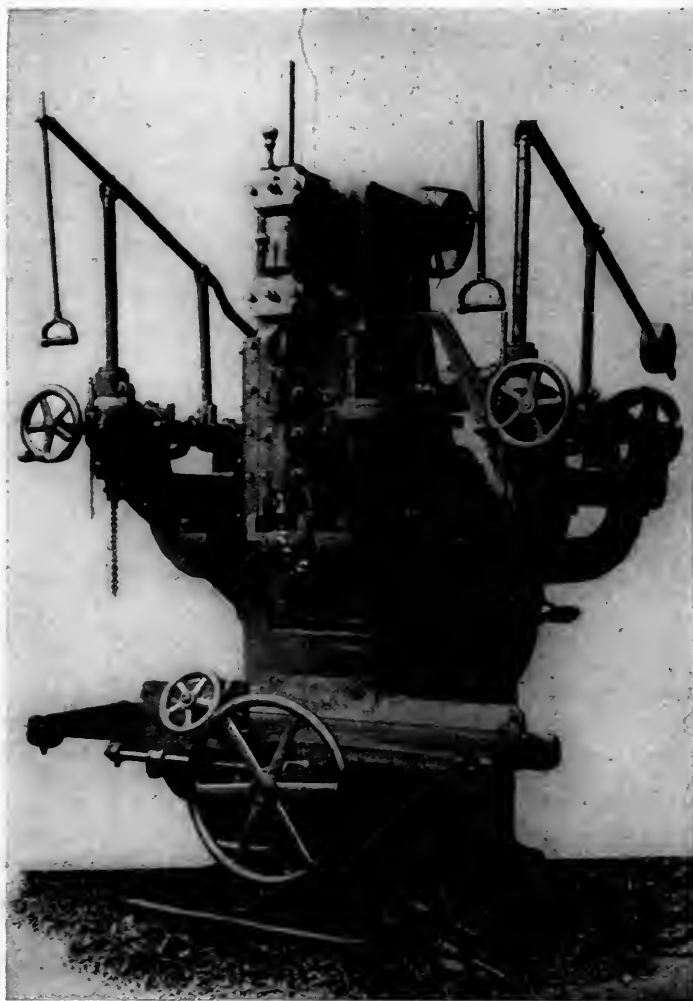
The Park Commissioners kindly granted permission to the Institute for the erection of the building, with the provision that it should be built of field rock and with pleasing proportions. The exterior was designed by Professor Homer. The building is of stone; it is fifteen feet square and contains the following apparatus, namely: a transit instrument of two and one-half-inch aperture, twenty-seven-inch focus, with a delicate level and micrometer eye-piece for latitude observations; a sidereal chronometer; a chronograph; a magnetometer; a dip circle; an altazimuth instrument, and various other smaller appliances, such as a heliotrope, a self-recording barometer, etc. During the present year it will be further equipped with a one-half seconds pendulum for determining the force of gravity.

Much work has been done at the observatory that could not before be performed at any of the Institute buildings. This is especially true of the tests on delicate spirit levels and the determination of constants depending on such observations. This is due to its freedom from vibrations, while its distance from all magnetic disturbances renders it especially favorable for observation with the magnetometer and dip circle.

The observatory, on account of its unique position, will be a valuable magnetic station and its observations will probably be incorporated in the general magnetic work of the United States Government.

DRAW BAR YOKES.

The subject of draw bar yokes was among the matters up for discussion at the January meeting of the Central Railway Club, the special feature centering on the weakness that is developing at the solid back end of the yoke, which breaks at the corners of the junction of the back end with the top and bottom. Mr. Waite mentioned a car coming under his observation where there was no doubt that red short iron was responsible for the failure. The importance of the radii of the bends at the back end was referred to by Mr. McCarty, who also pointed out the necessity for avoidance of square corners at that point. The reduction of thickness of material at the corners of a one by four-inch yoke was shown by Mr. West to be fully $\frac{1}{4}$ inch, which was due to the drawing of the metal over the form on which they were shaped. Many of the yokes he found were reduced to even less than $\frac{3}{4}$ inch thick at the corners. He understood that the Cleveland City Forge had devised a means of upsetting these corners and were furnishing a pocket which he was using. Mr. Waite thought that accounted for the reason why he had no trouble on his road, as he used the Cleveland City Forge Company's pockets. There is no doubt that reinforcing the corners is a good thing to prevent breakage, and Mr. McCarty's proposal to increase the radius of the ends will be found beneficial in all cases.



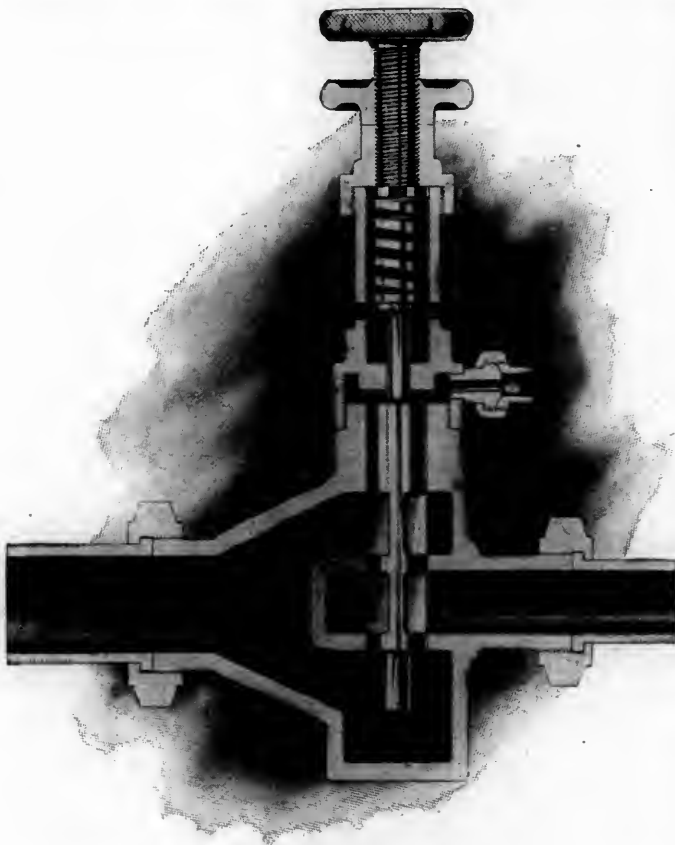
A New Vertical Hollow Chisel Car Mortising Machine With Auxiliary Boring Attachments.

the housing, the chisel ram, boring attachments and table. The housing has provisions for taking up wear, and has a lateral movement for properly locating the chisel over the work. The chisel-ram carries the boring spindle, the latter running in a long self-oiling bearing. There are stops by which the vertical movement of the ram is regulated for the depth of mortise; this movement is 16 inches, while the lateral action, with the housing is 14 inches. The chisel-ram has a reciprocating motion due to reversing friction and gearing. The table on which the work is supported is 4 feet 6 inches long, and also has stops to control the movement for the length of mortise required. The table is operated by a hand wheel in connection with a rack and pinion, and has an adjustable clamp for hold-

"ECLIPSE" REDUCING VALVE.

For Locomotives and Marine Service.

This reducing valve is simple and is making a name for itself on several railroads and steamships. Steam enters the valve through the pipe shown at the right hand side of the engraving. The piston is loose for vertical movements, and in the absence of steam pressure it drops to the bottom of the casing and leaves the valve passage open. As the steam pressure accumulates in the outlet connection, at the left, it acts upon the piston, forcing it up into the cylinder on top of the valve and the pressure of steam in the outlet side is governed by the tension of the spring in the housing above its piston. When screwed down this spring holds the piston open until balanced by the steam pressure, whereupon the valve closes.



The "Eclipse" Reducing Valve.

It is stated that the outlet pressure is not affected by variations in the boiler pressure. One superintendent of motive power has remarked that it was so simple that he was almost afraid to trust his men with it. There are but four working parts, the valve, valve pin, spring and screw. This valve is now in use on the Chicago Northwestern, the Cincinnati, Hamilton & Dayton, the Atchison, Topeka & Santa Fe, the "Big Four" and several other roads, and also on ships of the Minnesota Steamship Company. It is manufactured by The John Davis Co., 51 Michigan Street, Chicago.

STUPAKOFF ON WIRE GAUGES.

Mr. S. H. Stupakoff read a paper on wire gauges before the German-American Engineers' Society at Pittsburg, Pa., on March 22, 1899, on which occasion every known gauge received attention from the speaker, who did not fail to hold up as an object lesson those familiar representations that are parodies on the name of gauge. From the ordinary slot gauge the speaker touched upon the refinement of the art as exemplified on the micrometer gauge, from which it was but a step to the instrument of the author's devising, called the comparometer,

a device intended for comparing different standards, though incidentally it serves to determine the standard dimensions, numbers of standard gauges and various correlated properties of objects dependent on their dimensions. The comparometer, by the inventor's description, combines a micrometer gauge for wire, plate, drills, etc.; it gives the weight for round and sheet metals, the number of threads per inch for standard machine screws and suitable tap-drills therefor, and it furnishes the means for comparing any or all of these data at a glance.

The mechanical principle involved in the comparometer is that of a plain spiral base combined with a radius vector, movable around its pole. A shifting of the radius vector causes some fixed point on it to recede from or advance toward the spiral. The rate of recession or advancement is in direct proportion to the arc traversed. This instrument replaces all gauges which are marked on its face, and as a micrometer caliper it combines with one or all of these gauges an accurate measuring instrument with divisions of 1,000ths of an inch, 64ths of an inch and 100ths of a millimeter. There is no doubt that this instrument is devised to fill a place never before occupied, and it will also lead to a better understanding of the metric system since readings in those values are directly comparable with the inch and its divisions, and would therefore hasten a familiarity with the system least understood, because transposition is not necessary.

PHENIX METALLIC PACKING.

The packing manufactured by the Phenix Metallic Packing Company of Chicago is highly commended by those who use it as possessing a great degree of efficiency in addition to its simplicity. These qualities have been demonstrated by a number of years of practical tests at the hands of engineers whose opinions carry weight. It is a self adjusting metallic packing, used in conjunction with a rubber combination which gives an elasticity peculiar to a purely fibrous packing. An anti-friction metal is used in the manufacture of this packing which makes oiling unnecessary. Owing to its elastic features, it may be used to replace any fibrous packing, and will require no changes in the stuffing box arrangement to be used in place of other packing.

The development of the iron and steel industries of the United States is considered by the "London Statist" as perhaps the most important economic question of our time. This authority says that America has now so developed her iron and steel industries that she must find fresh outlets for her products. "Such outlets she is finding, as we believe with profit, in foreign markets for certain products. For other products, however, she will need to create a new shipbuilding industry of her own, and what has been done or is being done in that connection we must reserve for future examination. No thoughtful man, acquainted with the American character, who considers the situation can fail to perceive that the greatest competition to be faced by British industry and enterprise in the future is that of American shipbuilding. It may be deferred a few years, but it is bound to come."

The delicacy of modern measuring instruments was strikingly shown in Professor Vernon Boy's determination of the density of the earth. The force which he then measured was, he has stated in a recent lecture, equivalent to a weight of

1
of a grain acting at the end of a lever 1 inch long.
12,000,000.—"Engineering."

PERSONALS.

Mr. A. C. Beckwith has been appointed Division Master Mechanic of the Illinois Central at East St. Louis, Ill.

Mr. Richard English has been appointed Division Master Mechanic on the Rio Grande Western, at Helper, Utah.

Edward S. Tabor, President and Treasurer of the Morse Twist Drill & Machine Company, died in New Bedford, Mass., March 10.

Mr. A. C. Deverell has been appointed Superintendent of the Car and Machine Shops of the Great Northern Railway, at St. Paul, Minn.

Mr. G. J. Kelly has been appointed Division Master Mechanic of the Baltimore & Ohio Railroad, with headquarters at Riverside, Baltimore.

Mr. G. De Vilbis, formerly of the Wabash Railroad, at Peru, Ind., is now in charge of the mechanical department of the Western Division of the Grand Trunk Railway.

The promotion is announced of Mr. E. T. White to the position of Superintendent of Motive Power of the Baltimore & Ohio to succeed Mr. I. N. Kalbaugh, transferred to the lines west of the Ohio River.

Mr. I. N. Kalbaugh, Superintendent of Motive Power of the Baltimore & Ohio at Baltimore, has been appointed Superintendent of Motive Power of the same road west of the Ohio River, with headquarters at Newark, O.

Mr. James Hocking has received the appointment of Master Mechanic on the New York, New Haven & Hartford at New Haven, succeeding Mr. J. W. Leary, who has taken the position of Superintendent of the Aluminum Plate and Press Company, at Plainfield, N. J.

John Kruesi, Chief Mechanical Engineer of the General Electric Company, at Schenectady, N. Y., died in that city February 22, at the age of fifty-six years. He was born in Switzerland, and upon coming to this country in 1870, he entered the employ of Mr. Thomas A. Edison, at Menlo Park.

Mr. Edwin G. Russell has accepted the position of superintendent of the Morris and Essex division of the D. L. & W. Railroad, succeeding Mr. A. Reasoner. Mr. Russell was associated with President Truesdale on the Minneapolis & St. Louis, where the latter gentleman was receiver of that road.

The appointment of Mr. J. W. Fitzgibbon as Superintendent of Motive Power of the Delaware, Lackawanna & Western, with headquarters at Scranton, Pa., is a new move on that system there having never been a supreme mechanical head on the road. Formerly the several master mechanics on the line reported directly to the General Manager.

Mr. W. L. Derr, who has been Superintendent of the Delaware Division of the Erie R. R., has received the appointment of Superintendent of the Susquehanna Division to succeed Mr. J. T. Maguire, who is transferred to the New York Division, where he succeeds Mr. W. W. Maguire, resigned. Mr. Derr's headquarters will be at Elmira, N. Y.

Professor W. F. M. Goss, of Purdue University, has been granted leave of absence, beginning April 1, for a trip abroad. After twenty years of such active work at Purdue, Prof. Goss merits this rest, and he will return with renewed energy to continue his admirable work. Prof. R. A. Smart will have charge of the department during the absence of Prof. Goss.

Mr. Michael D. Wild has been made Secretary of the Baltimore & Ohio Southwestern, succeeding Mr. Edward Bruce, and Assistant Secretary of the Baltimore & Ohio Railroad, with headquarters at No. 2 Wall Street, New York. For several years Mr. Wild has held a very responsible position with the Baltimore & Ohio Railroad, in Baltimore, and the change is a promotion and recognition of his valuable services.

Mr. J. T. Harahan, Jr., has been selected to represent the Charles Scott Spring Company, in association with Mr. William V. Kelly, with headquarters in the Fisher Building, Chicago.

Mr. W. E. Symons, Superintendent of Motive Power of the Plant System, is now also in charge of the car department by an extension of his jurisdiction, whereby the Master Car Builder reports to him.

Mr. H. A. Parker, who has just been appointed Vice-President and General Manager of the Chicago, Rock Island & Pacific, began his railroad service as chairman in the construction of the road in 1866, at the age of fifteen. He has filled many important and responsible positions, such as Division Engineer and Chief Engineer, and Assistant to the President. His recent activities have been in connection with the extensive track elevation improvements in Chicago. The appointment may be considered in the light of a triumph of engineering skill, combined with ability in management.

Mr. William H. Harrison, Superintendent of Motive Power at Newark, Ohio, of the Trans-Ohio Division of the Baltimore and Ohio Railroad, has laid aside his railroad burdens, after a period of forty-five years of service on the B. & O. Mr. Harrison's railroad work began with the Baltimore & Susquehanna Railroad, when he served his apprenticeship. In his long term of active railroad life he has witnessed the transition of the motive power units from the primitive Eastwick and Harrison engine and the "camel back" to the powerful freight engine of the present. Mr. Harrison retires at the age of 67 years, with an enviable record.

Mr. Alexander Kearney, Assistant Engineer of Motive Power of the United Railroads of New Jersey, has been appointed Assistant to Mr. F. D. Casanave, General Superintendent of Motive Power of the Pennsylvania Railroad, with headquarters at Altoona and the title of Assistant Engineer of Motive Power. Mr. Kearney's railroad career began with his apprenticeship in the Altoona shops, after which he was appointed Road Foreman of Engines of the Philadelphia Division, and following that, Assistant Engineer of Motive Power of the Philadelphia, Wilmington & Baltimore.

Sir Douglas Galton is dead. He was born in Worcestershire, England, in 1822, and was educated at the Royal Military Academy, Woolwich, where he passed the highest examination on record, and took first prize in every subject. He received a commission in the Royal Engineers in 1840, and eventually became Inspector of Railroads, and Secretary of the Railroad Department of the Board of Trade, in which capacity he made an official visit to the United States in 1856. In 1860 he was appointed Assistant Inspector of Fortifications, and from 1862 to 1870 he was Under Assistant Secretary of State for War. Later he became Director of Public Works and Buildings, and in 1875 he retired. From 1870 to 1895 he was General Secretary of the British Association, and from 1895 to 1896 he was President of that body. He was also a member of the council of the Royal Society, and constructed the Herbert Hospital at Woolwich. He was the author of "Healthy Dwellings" and "Healthy Hospitals," and other works, and was one of the greatest British authorities on questions of sanitation. The work for which he is best known in the United States was that in connection with the celebrated air brake tests which were carried out by his joint work with Mr. Geo. Westinghouse in England.

Mr. G. R. Henderson, member A. S. M. E., has resigned as Mechanical Engineer of the Norfolk & Western Railway to join the engineering staff of the Schenectady Locomotive Works.

He is widely known in this country and abroad by his valuable contributions to the technical press and his excellent work in the preparation of reports presented to the American Railway Master Mechanics' Association. No more thorough reports have been submitted to the association than those of the committees on tonnage rating last year, and on the proper ratio of heating surface and grate area to cylinder volume presented in 1897, he being chairman of both committees. He has also written many valuable articles for the "American Engineer." Mr. Henderson began his railroad work by an apprenticeship at the West Philadelphia shops of the Pennsylvania Railroad in 1878. In 1881 he went to the drawing room at Altoona to become assistant Chief Draftsman. He went to Roanoke, Va., in 1887 as Assistant Superintendent of the Roanoke Machine Works, and since 1890 he has been Mechanical Engineer of the Norfolk & Western. One of his notable locomotive designs was illustrated in our June, 1898, issue, page 181, and his work in that position has given him the reputation of being one of the foremost locomotive designers. His new title is Assistant Mechanical Engineer and he will assist Mr. Pitkin and Mr. Sague in designing new locomotives. His qualifications as an engineer and his judgment from a wide experience render him a most valuable officer in locomotive building works, but his loss to the railroad service will be serious. Such men are greatly needed, and railroad managers should ask themselves the question: "Why do these good men leave the railroads?"

F. C. Weir, President and General Manager of the Weir Frog Company, of Cincinnati, died March 1, and is succeeded by Mr. L. C. Weir. Mr. Weir was a very able man in his line of business, and his career was one of marked success. He was born at Oxford, Conn., in 1832, and entered the New Haven railroad shops at seventeen years of age, where he learned the machinist trade. He then became locomotive engineer on that road, and in a few years was made foreman of a department of the shops. In 1855 he went to Russia and served under Ross Winans as one of the engineers in building the Russian railway, running from St. Petersburg to Moscow. He was General Manager of the St. Petersburg Division, and after serving in that capacity for several years he returned to this country in 1863. In 1872 he became interested in the manufacture of railroad frogs. In 1883 he organized the Weir Frog Company at Cincinnati, O., and developed that business, giving it his personal and entire attention for many years. Mr. Weir invented a great many frogs, switches and crossings, and machines for manufacturing them, and he thoroughly systematized the business. He was a man of unusual ability in all directions connected with manufacturing. His personal characteristics were very strong, and the attachment between him and his employees as continued through the latter years of his life was very unusual. He seemed to live for the benefit of those around him, and entered into their joys and sorrows with a spirit which only a great and benevolent man can show. He was a public-spirited man, and took the keenest interest in all the economical questions of the day. He was a member of the American Society of Civil Engineers since 1872; was also a member of the Engineers' Club of Cincinnati; the Engineers' Club of New York; Engineering Association of the South; the Engineers and Architects' Club of Louisville.

Mr. William Ledyard Cathcart has been appointed adjunct professor of mechanical engineering at Columbia University, and will be Professor F. R. Hutton's principal co-operator in the department. Mr. Cathcart is well known as a writer upon engineering subjects, the chief of which have been in the line of marine, mechanical and civil engineering. Owing to his training and experience in marine engineering, it is natural to infer that Columbia is to give special attention to marine subjects, which is specially appropriate because of its location in this important seaport. Mr. Cathcart's professional record in the United States Navy began with

his appointment as cadet engineer in October, 1873. His service with the Academy ended in June, 1875, was followed by assignments to the North Atlantic station on the "Canaan-daigua" and "Plymouth," 1875 and '76, and to the "Adams," '76 to '78. He was commissioned as assistant engineer during this interval, in July, 1877. May, 1878 to '81, he was with the flagship "Richmond," on the Asiatic Station. Returning to America he was assigned in November, 1881, to inspection duty at Philadelphia until January, 1884, when again he had three years' sea duty on the U. S. S. "Ossipee" at the Asiatic Station, until 1887. Returning again to inspection duty at Philadelphia, from June, 1887 to April, 1889, he was then transferred to the "Yorktown" until the summer of that year, when he was assigned to duty at the League Island Navy Yard. He passed his examination to the grade of Passed Assistant Engineer in December, 1884, and after becoming interested in a particular line of manufacture, resigned from the Navy to pursue the work of his choice in January, '91. He received an appointment from Mr. William H. Webb, founder of Webb's Academy, as Instructor in Marine Engineering, in the spring of 1897, but on the breaking out of the war he volunteered and was appointed Chief Engineer June 10th, '98, with appointment to the Bureau of Steam Engineering at Washington. He was honorably discharged in October, '98, and received his appointment at Columbia University in February, 1899. He will begin duty in his new position in October next.

BOOKS AND PAMPHLETS.

"The Centrifugal Pump, Turbines and Water Motors, Including the Theory and Practice of Hydraulics Specially Adapted for Engineers." By Charles H. Innes, M. A., Lecturer on Engineering at the Rutherford College, Newcastle on Tyne. Second edition. The Technical Publishing Co., Ltd., and D. Van Nostrand Co., 23 Murray St., New York, 1898. Price, 3 shillings 6 pence.

This book is divided into seven parts, of which the first treats of general principles concerning motion of water, the second with pressure engines producing rotary motion, the third with turbines and the Pelton wheel. Theory and mathematical considerations are given important places in the work. A chapter from the pen of C. A. Parsons describes his form of steam turbines. A chapter on water turbines shows the close agreement between theory and experiment. Centrifugal pumps, fans, the hydraulic works at Niagara and the hydraulic buffer stop, each have chapters. Trigonometric and graphic methods are freely used. The book might have been devoted entirely to hydraulic pumps and motors to somewhat better advantage. Steam turbines, fans and railroad buffers are all interesting, but a book entitled "Centrifugal Pumps and Turbines" does not appear to be a promising one to aid in the search for literature on fans, buffers and steam engines. This criticism does not, however, reflect discredit upon the other parts of the work. The engravings are not all bad, but many are too wretched to pass unnoticed.

"The Commercial Management of Engineering Works." By Francis G. Burton. The Scientific Publishing Co., Manchester, England, 1899. Price, 12 shillings 6 pence.

The author of this book was formerly secretary and general manager of the Milford Haven Shipbuilding and Engineering Co., and he has written for young engineers and foremen who have not established systems of their own. No attempt has been made to lay down rules, but rather to show difficulties and offer suggestions. The book is arranged in logical order and presents in considerable detail the author's idea of what a complete system of shop and office management should be. The details are, we think, much too complete in respect to very little things and too little is said about others that are most important. The vital importance of knowing costs of work done as a basis for estimating and managing is considered, but too much space is given to clerical and accounting matters to permit an unobstructed view of the broad principles of commercial management. The book is worth reading by those who have already established systems, for it offers suggestions that may tend to improvement. We should say that if the vast amount of detail outlined in this book is necessary to meet

conditions in English "Engineering Works," these conditions are much more complicated than ours. We do not need to be told that all forms of which it is intended to take press copies should be printed in copying ink, but we would like to know how English manufacturers keep record of the cost of production. The general subject of costs is treated, but its effectiveness would be greater if more elaborate. The book is attractive in appearance, the letterpress and binding being excellent. Mr. Burton believes in advertising, for he says: "A saving of advertising expenses generally means a much greater reduction in the amount of orders."

The Testing of Materials of Construction. By W. C. Unwin. Second edition. Longman's Green & Co., New York, 1899. Price, \$6.00

In addition to the necessity for bringing this work up to date, the second edition was needed because of the important place assumed in modern engineering practice by experimental investigation into the properties and qualities of the materials used by engineers. The materials themselves have improved and the appliances for testing are not backward in this respect. The author's name is a guarantee of thorough, scientific and sensible treatment upon a careful plan. The plan is to handle the subject scientifically and commercially. The former contains the mathematical and exact treatment, while the latter is a guide in the selection of material for engineering purposes. The broad divisions of the work are, elasticity, deformations and plasticity, hardness, the machinery and apparatus for testing, and a wide range of results of tests upon the materials of engineering that are in general use. It is a large book, and would have been much larger if the author had fully treated all that we would like to have him include. Iron and steel very naturally occupy a large share of space, both in the section given to records and the curves of behavior of specimens and in the part given to the manipulation of testing. The progress of 10 years since the first edition appeared has been thoroughly brought up to date, except in regard to the improvements chemically, which are omitted. It is a valuable work and will be obtained by every up-to-date engineer. It is a scientific study of testing and a work of record which is likely to stand a long time as an authority in practice. The printing and binding are excellent, and most of the engravings are good, while others are out of place in such an admirable book. It has a good index.

List of Officers and Members of the American Society of Naval Engineers, 1899.

This pamphlet, received from Chief Engineer A. B. Willits, U. S. Navy, contains a list of officers, members and associate members of the society and lists of the exchanges and subscribers to the proceedings.

"The Tokio Imperial University Calendar, 1897-1898. Published by the University, Tokio, Japan."

Opening with a calendar of the opening and closing months of the college year, there is an interesting historical summary of the life of the institutions forming the University, tracing its development from its origin by the union of the late Tokio Daigaku, Kobu Daigaku and Tokio Nornigakko.

"Twentieth Annual Report of the State Board of Agriculture College, Including the Eleventh Annual Report of the Agricultural Experiment Station, Ft. Collins, Colorado. 1898."

The report covers the aims and purposes of an agricultural college, and gives evidence of more than usual care in its preparation.

Society of Naval Architects and Marine Engineers, Names of Members, 1899.

This little pamphlet contains the names and addresses of the members, the constitution and rules and a list of the papers contained in the five volumes of the proceedings of the society. This is one of the most important of the technical engineering societies, and the record of subjects presented at the five annual meetings shows the scope and character of the discussions. The secretary is Mr. Francis T. Bowles, 12 31st street, New York.

Prospectus of the Working Men's College, Melbourne, Australia. Twelfth edition. 1899.

This college was founded to improve the education of those

who work, and especially to facilitate the attainment of a knowledge of handicrafts, arts, sciences and languages, by the establishment of classes, workshops, laboratories, reading rooms, libraries, museums, and by other means, as the council may direct. The curricula embrace manual training, as well as the higher courses, and both sexes are admitted.

Statistical Abstract of the United States, 1898. Twenty-first Number. Population, Finance, Commerce, Agricultural and Other Leading Products, Mining, Railroads and Telegraphs, Immigration, Education, Public Lands, Pensions, Postal Service, Prices, Tonnage, etc. Prepared by the Bureau of Statistics, under the direction of the Secretary of the Treasury, Washington. Government Printing Office, 1899.

Under the above comprehensive statement of the contents of this work is to be found information of interest to the banker, the business man and the farmer, covering as it does every aspect of foreign and home trade.

"On the Organization of Engineering Courses, and on Entrance Requirements for Professional Schools." By Dr. R. H. Thurston, Director of Sibley College, Cornell University, Ithaca, N. Y.

This is a pamphlet reprinted from a paper which has for its object, as stated in the opening paragraph, a consideration from a professional standpoint of the necessity of organization of professional schools, and those of engineering particularly. Consideration is also given to the proper method of organizing such professional institutions and especially their curricula, and the logical and best methods of discovering their essential, and their desirable, though non-essential, entrance requirements, and, finally, of securing a proper and the best method of relating their courses of instruction to those of the academic schools, preparatory and others. The arguments in consonance with the objects named above, were clearly put in the usual style of the distinguished author, but are too lengthy for even a fragmentary review, although very interesting.

Register of the Lehigh University, South Bethlehem, Pa., 1898-1899. This register fully explains the founding of the university and its incorporation in 1866 by the Legislature of Pennsylvania. The curriculum embraces civil, mechanical, mining and electrical engineering, metallurgy, chemistry and all needful collateral studies. A school of General Literature is also established and thoroughly equipped, and the classical course, the Latin-Scientific course, and the course in Science and Letters.

Dixon's "Teachers' Note Book." Joseph Dixon Crucible Company, Jersey City, N. J.

This is an interesting pamphlet and neatly gotten up. It is devoted entirely to a description of the materials entering in, and the manufacture of the Dixon American Graphite Pencils.

The Peerless Rubber Company has issued a little explanatory folder of their Rainbow packing and gaskets and the information is conveyed by means of plain language, without extravagant claims of superiority or attempts to belittle other products in the same line. The little flyer is printed in brilliant colors, and is sure to attract attention to the output of this well known house.

A pamphlet from the B. F. Sturtevant Company, of Boston, furnishes some interesting figures, resulting from observations made in fuel tests under mechanical draft, of the 1,000-horse power plant of the United States Cotton Company, at Central Falls, R. I. An annual saving of \$6,500 was shown by the use of a fan costing \$550, by which an inferior mixture of coal was made to replace the Cumberland coal used before. The speed of the fan engine is regulated automatically and accommodates itself to the steam pressure. Notwithstanding there is no economizer used with the mechanical draft, the gases are said to have a temperature not higher than 400 degrees Fah.

The Detroit Graphite Manufacturing Company, Detroit, Mich., have issued an attractive pamphlet containing a large number of excellent half-tone engravings illustrating a portion of the important buildings, bridges, ships, railroad cars, gasometers and other structures which have been painted with "Superior Graphite Paint." It also contains statements of the merits of this paint as a durable metal coating. The array of

important works upon which the paint has been used is a convincing argument, and added to this are reports of severe tests imposed upon it, such as the exposure of pieces of iron coated with it when placed in boiling sulphuric acid. The acid eats away the iron entirely, and a piece painted on one side is completely decomposed, leaving only the film of paint uninjured. The pamphlet should be obtained and examined by all who are concerned with the protection of metallic structures. It is very attractively printed, and the engravings are interesting, aside from their exhibit of the protective properties of the paint. We think the best testimonial to the value of this paint is the fact that the consumption for 1898 was double that of the previous year. The company is now constructing a large five-story addition to the factory, in order to provide for the increasing demand.

Air Compressors, Air Hoists, Air Appliances.—The Curtis & Co. Manufacturing Co., Engineers and Machinists, St. Louis, Mo., have issued a catalogue of the regular product of their works which is well worth sending for. The chief of these specialties are automatic air compressors driven by belts, steam engines and gas or gasoline engines. The firm produces a line of compressors which are unique for their simplicity, compactness, and we should say also for efficiency, as far as this may be judged by examination of the interesting designs. The details and methods of operation have been studied with care and the result is a series of machines that are sure to interest those who have occasion to use air compressors. The valves are simple and easily accessible, the principle of governing is to relieve the machine from doing work when the desired pressure is secured, without stopping the machine, and the clearance of the machines is kept down to about 1½ per cent. The parts of the machines are standardized, so that repairs may be promptly made and the tests at the works are said to be so rigid as to eliminate breakdowns. The gas engine combined with the compressor, is a very compact and convenient machine that is adapted to many kinds of service where a steam boiler cannot be used. The catalogue also includes a number of air hoists and shows their applications to cranes and travelers. It also includes line drawings, showing the foundation plans of the various sizes of compressors and concludes with some strong testimonial letters from well known manufacturing concerns.

The Dayton Malleable Iron Company, Dayton, Ohio, have issued a new series of circulars, illustrating their product in malleable iron for railroad use. These are all standard size, (6 by 9 inches), and we do not know of any better way to present the advantages of these specialties. The engravings are excellent and are clear enough to show the advantages of this material with very little description. The one describing the car door fastener is specially well done, both as to engravings and arrangement, all of the parts being lettered for convenience in ordering. This fastener is well known; it is self contained and does not require pins, hooks or chains, the locking being effected by a gravity button, which is loosely attached to the door fastener. This fastener is recommended by 12 years of satisfactory service. Among the circulars several others may be mentioned. The Dayton brake wheel is a needed improvement over ordinary cast iron wheels and is sold at a low price. The Kelly brake fork, which was illustrated on page 63 of our February, 1898, issue, offers the advantages of strength, (they have been tested to 40,000 pounds), combined with an absence of welds, and there are no welds in the rods to which they are connected, as an examination of our description will show. Gunn's roof saddle, or running board bracket, was illustrated on page 277 of our August issue last year, and it received strong indorsement from Mr. A. E. Mitchell, Superintendent of Motive Power of the Erie R.R., which will be found on page 227 of the proceedings of the Master Car Builders' Association for 1898. Mr. Mitchell stated that this bracket was introduced on the Erie in 1894, and that it had been applied to every car receiving general repairs in the shops of that road since then. Drawings illustrating the bracket and the manner of attachment are printed on pages 228 and 229 of the volume of proceedings referred to. In wrenches for shop and track work these manufacturers are prepared to supply any size or form; also, ends for track gages, ground switch latches, rail braces, coal picks, fire shovels and drinking cups. These are all presented in the circulars, together with shop and engine torches, all of malleable iron. The circulars are well printed and are attractive.

EQUIPMENT AND MANUFACTURING NOTES.

The Swedish State Railways have placed an order for 20 compound locomotives with the Richmond Locomotive Works.

The Pennsylvania Railroad is said to have in view the construction of 123 new locomotives this year at their Altoona shops.

The Magnolia Metal Company has changed the address of the Chicago office to the Fisher Building, 281 Dearborn street. They were formerly in the Trader's Building.

The satisfactory condition of business of the Q & C Co. and the attitude of that concern toward its employees, is shown by a recent advance in wages of the manufacturing force of about 10 per cent.

The Howard Iron Works, Buffalo, N. Y., large manufacturers of vises, bolt cutters and other machinery, have had 25 years' experience in this line, and are prepared to furnish tools of this kind that are thoroughly well known to be satisfactory and efficient.

The Ohio Falls Car Works is now the property of the American Car and Foundry Company. According to the "New York Commercial" the purchase price is \$2,500,000, which was turned over to the old owners of the Jeffersonville plant March 21. It was a cash transaction.

The McCord journal box is to be applied to 1,000 cars building for the Lake Shore, on 2,000 for the St. Louis, Peoria & Northern, 800 for the Minneapolis & St. Louis, 400 for the Duluth, South Shore & Atlantic, and a number of other smaller lots for which contracts have been recently closed.

The Philadelphia works of the Charles Scott Spring Co. were destroyed by fire March 13. The company announces that preparations have already been made to rebuild the plant, and in the meantime temporary arrangements have been made to carry on the work on orders, so that there will be no delay whatever in filling them.

The Automatic Rail Joint Spring Company, of Chicago, have received orders for their springs from the Denver & Rio Grande. The springs have also been placed in service on the Chicago & Northwestern, the Atchison, Topeka & Santa Fe, the Chicago, Rock Island & Pacific, the Illinois Central and the Wisconsin Central roads. We are informed that it has given satisfactory results in every case.

The Ingersoll-Sergeant Drill Company have issued booklet No. 153, which contains an index to their catalogue, No. 41. This booklet contains some fine half-tones of their new drills and compressors, in addition to their descriptive matter and testimonials from users of their machines. The index clearly refers those interested directly to the designation numbers of the special catalogues that will furnish the desired information.

Mr. George Place has been appointed Eastern agent of the American Tool Works Company of Cincinnati, with office in the Equitable Building, 120 Broadway, New York. Mr. Place has an unusually wide and valuable acquaintance and is one of the best known representatives in the machine tool business, having been connected with Bement Miles & Co. for more than 16 years. He accepted the position after a most careful investigation of the product of the American Tool Works Company, in which he found their product equal to the best from any manufacturers, and with their ample facilities and his own abilities the office will undoubtedly conduct a large amount of business. Mr. Place is also agent for the J. A. Fay & Eagan Company, the largest manufacturers of woodworking machinery, and is prepared to furnish complete machinery for car and locomotive shops.

The Baltimore & Ohio has decided upon changing the system of running a pay car to the modern one of paying by checks, the distribution being done by the station agents. Where about

a million dollars per month was disbursed by a pay car, requiring three weeks for the circuit, the old system became too burdensome and awkward.

Eastern business men when traveling between Chicago and St. Louis should go via the Chicago and Alton. The trains are convenient and comfortable and they run on time. They will find the accommodations equal if not superior to those of the best Eastern trains, because some of the best work of the Pullman Company has been put into the cars used on this road.

The Charlotte Machine Company, one of the largest mill machinery and construction houses in the South, which has equipped many of the leading mills, decided to go into voluntary liquidation March 22. Capt. H. S. Chadwick, the principal stockholder, committed suicide in Boston several weeks ago. The North Carolina Car Company, car builders and wheel manufacturers, of Raleigh, have been placed in the hands of a receiver.

The Hornish Boiler Cleaner, which was illustrated and described in our issue of December, 1898, page 413, is attracting attention abroad as well as at home. We are informed that Mr. G. E. Cardew, member I. C. E., Locomotive and Carriage Superintendent of the Burma Railways of India has sent drawings of two types, Classes F and O, of locomotive boilers of that road, to Mr. Hornish in order to permit of designing the boiler cleaner for use on the engines of that road.

The Baltimore & Ohio track improvements are being continued. The next rectification of line to receive attention is at the "Doe Gully" curves, where preparations have now been going on for about three months. The Chief Engineer says that the improvement will do away with one of the most objectionable pieces of track on the second division since the Seven Curves were eliminated, and will remove four reverse curves. It will not only make a much better riding track for fast trains, but materially assist the westbound freights in climbing this grade.

One of the results of the recent inspection trip of the Baltimore and Ohio Railroad lines west of the Ohio River is an order for a double track on the Central Ohio division from Bellalre to Cambridge, Ohio, a distance of fifty-three miles. This portion of the road is congested with freight at all times, and the proposed improvement is in the nature of a necessity. It is estimated that the second track will cost in the neighborhood of one and a quarter million dollars. There are a number of heavy grades between Bellalre and Cambridge which will be cut down, and all of the bridges will be replaced with new double track steel structures. It will take at least a year to complete the work.

The Pencoyd Iron Works have sent a gang of men to Africa for the purpose of building a bridge across the Atbara River, in the Soudan, near Khartum. The seven spans of the bridge, with a total length of 1,110 feet, have already been shipped. The order was placed with the Pencoyd Iron Works by the British War Office less than six weeks ago, the company agreeing to build the structure in seven weeks. The Pencoyd Company was given preference over the English bridge builders because the latter had stated that it would require seven months to complete the structure. The British War Office was anxious to have the bridge completed before Fall, in order to facilitate the operations of Gen. Kitchener.

The Westinghouse Air Brake Company have issued a series of three bulletins in pamphlet form (6x9 inches) that cannot but be of great aid to those interested in the care and use of air pumps. Bulletin No. 1 treats of the maintenance of pumps in concisely worded suggestions. Bulletin No. 2 is devoted to the testing of air gauges, pump governors and reducing valves, explaining the mechanical operations involved in the work. Bulletin No. 3 concerns the capacity and location of main reservoirs in locomotives, giving reasons why certain locations of the reservoir are objectionable, and why in some particular cases a large reservoir capacity is not only desirable but necessary to the best operation of the brake.

The Ajax Metal Company, encouraged by the success of their well known bearing metal and Ajax tin have placed on the market a metal under the trade name of "U. S. Tin" for use in the manufacture of all castings in which tin is one of the elements. An incentive to purchasers to use "U. S. Tin" is furnished in the price, which is made so far below that of the imported tin that there can be no doubt of the immediate success of the new brand, more especially when it is known that it will make a superior metal, castings sounder and more homogeneous, and a better wearing metal, much richer in color and of greater tensile strength; besides, it can be used in the same proportions as the imported tin. Small lots of "U. S. Tin" will be sent on approval to responsible people in order to convince all that it is superior to imported tins.

The order for ten high-speed passenger locomotives recently placed by the French State Railways with the Baldwin Locomotive Works is believed to be the first built outside of France for French railways. The order was placed by a commission that represents the French Government and is now in this country. The commission consists of MM. Boell, Assistant Engineer-in-Chief of Motive Power; Charrier, Division Superintendent of Traffic, and Thore, Inspector of Motive Power. The prospective rush of travel during the Exposition is the reason for these timely preparations by the European roads. The head of the commission said, with reference to the respective performance of the American and French engines, that they can tell only after exhaustive tests whether the American engines are superior to the French for their service, where consumption of fuel is a matter of prime importance. His opinion is that the American engine uses more fuel than the French engine, but it remained for a trial to demonstrate that point.

Walter A. Zelnicker, 202 North Third street, St. Louis, Mo., manufacturer and agent for railway, mill and factory supplies, including boilers, engines and machinery, reports a very satisfactory condition of business. He is prepared to furnish everything used in the construction, operation and maintenance of railways and shops. Among his well-known specialties are "Zelnicker" prepared roofing, which is strongly recommended for car sheds, roundhouses and warehouses. Besides being durable, it is low in cost and is claimed to be the cheapest and best for these purposes. Mr. Zelnicker is agent for "Positive Lock Nut Washers," the "Johnston" wrench, the Cyrus Roberts hand and push cars, also for the product of the Trenton Iron Company and for track velocipedes, steel wheelbarrows, brake chains, spikes and rail splices. He makes a specialty of the "Zelnicker" second growth hickory maul handles, one of which is guaranteed to be equal in durability to six ordinary handles. This may be considered a small item, but it is an important one.

Trials of the Babcock & Wilcox boilers of the marine type are noted in "The Mechanical Engineer." The torpedo gunboat Sheldrake, which was specially commissioned at Devonport on the 14th ult. for experimental purposes, has now been ordered to carry out a series of trials, under service conditions, of the Babcock & Wilcox boilers, with which she was equipped during her refit last year. There will be in all nine runs, each of 1,000 miles continuous steaming, at various horse powers from 1,500 to 2,100, the speeds being from 12 to 17 knots approximately. During these runs only three of the four boilers with which the ship is fitted will be used, the same three boilers for all trials. The Sheldrake's four boilers are each capable of developing 1,000-horse power, using natural draught. The vessel has just completed the first of the series of trials. The run of 1,000 miles was made between Plymouth and the Isle of Man under favorable conditions, with three-fourths of the boiler power of the ship. An average of 1,500.3 horse power was realized. The boilers in use gave a grate surface of 189 sq. ft. and a heating surface of 6,528 sq. ft. The coal consumption was 12.31 lbs. per square foot of grate surface, and 1.61 lbs. per indicated horse power. The total amount of coal used during the run of 1,000 miles was 71 tons 14 cwt., which is regarded as highly satisfactory. It is believed that the coal consumption will be further reduced during the trials, for the second of which the vessel is now being prepared.

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VAUCLAIN FAST PASSENGER COMPOUND LOCOMOTIVES.

Atlantic Type.

Chicago, Burlington & Quincy Railroad.

It has been known for some time that the Baldwin Locomotive Works were building new fast passenger locomotives for the fast mail trains between Chicago and Omaha. We are now enabled to print an engraving from a photograph and the chief characteristics of the design.

The Baldwin compounds built for the exacting passenger service on the Chicago, Milwaukee & St. Paul, between Chicago and Milwaukee (see "American Engineer," August, 1896, page 170), were considered exceedingly powerful engines, and it is well known that they have made good records, but the new Burlington engines are much more powerful and a great deal more may be expected from them in service. This design is especially interesting at this time because of the unusual attention which has been attracted to the subject of powerful

eral of the 10-wheel type now used in passenger service, but is not by any engine with four driving wheels of which we have record. The engine presents a very attractive appearance and the performance will be watched with a great deal of interest, especially because of the prominence given to this type in recent discussions. The tender is carried on three axles. The chief dimensions are as follows:

Cylinders.

Diameter high pressure	13½ inches
" low "	23 inches
Stroke	26 inches
Valve	Balanced piston

Boller.

Diameter	62 inches
Thickness of sheets.....	11/16 inches
Working pressure	210 pounds
Fuel	Soft coal

Firebox.

Material	Steel
Length	120 inches
Width	40 inches
Depth	Front, 74½ inches; back, 70½ inches
Thickness of sheets, sides	⅝ inch
“ “ “ back	⅝ inch
“ “ “ crown	1½ inch
“ “ “ tube	1½ inch

Tubes.

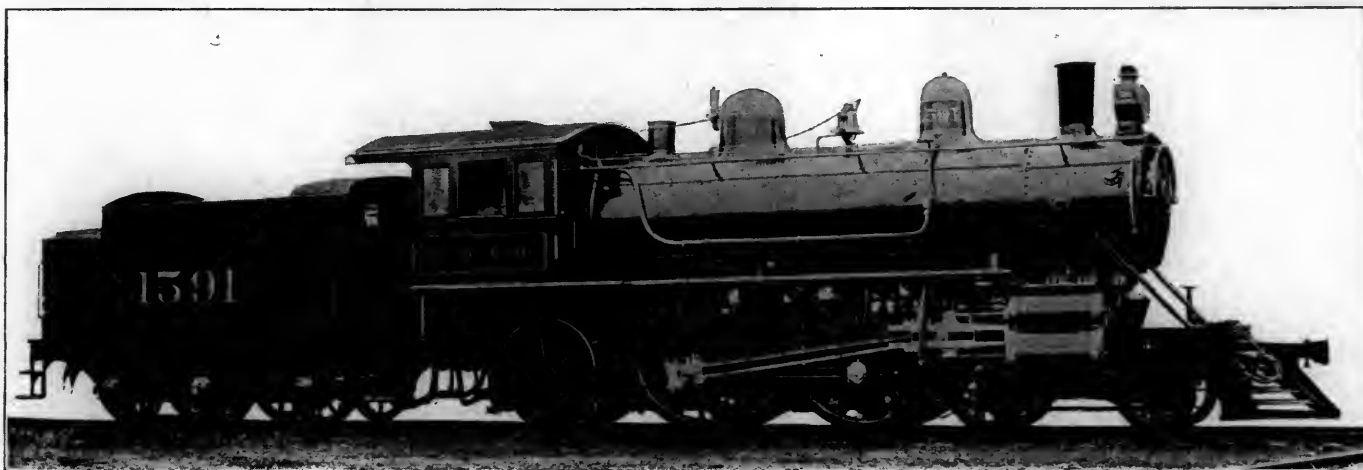
Number	248
Diameter	2 1/4 inches
Length	16 feet

Heating Surface.

Firebox	186 square feet
Tubes	2,324 square feet
Total	2,510 square feet
Grate area	33.6 square feet

.....
Driving Wheels.

Diameter outside	84 inches
Diameter of center	78 inches
Journals	8½ inches by 12 inches



Vauclain High Speed Passenger Locomotive.
Chicago, Burlington & Quincy Railroad.

BALDWIN LOCOMOTIVE WORKS, *Builders.*

passenger locomotives by the records of the Atlantic City service on the Philadelphia & Reading, and the data from the Purdue University model. The heating surface of the C. M. & St. P. engines, 2,244 square feet, is mentioned because, at the time, it was considered specially large, but that of the new Burlington design is 2,510 square feet, exceeding that of the C. M. & St. P. engines by 266 square feet.

The grate area of the Burlington engines is 33.6 square feet, and the firebox is 120 by 40 inches. It is 74 inches deep in front and 70 inches deep at the back. The tubes are unusually long, 16 feet, and it is noteworthy that they are $2\frac{1}{4}$ inches in diameter and but 248 in number. The cylinders are $13\frac{1}{2}$ and 23 by 26 inches, which, we believe, are the largest that have been built for fast passenger engines of this type. Those of the Atlantic City engines of the Philadelphia & Reading, and also of the C., M. & St. P. engines, are 13 and 22 by 26 inches. The Burlington engines have $84\frac{1}{2}$ -inch driving wheels, which, with the high steam pressure, large cylinders and large boiler, will make a good combination, particularly in service where comparatively long runs are made between stops.

The weight of this engine, 159,050, has been exceeded by sev-

MR. F. A. DELANO, *Superintendent of Motive Power.*

Engine Truck Wheels.

Diameter 36 inches
Journals 5½ inches by 10 inches

Trailing Wheels.

Diameter 54 1/4 inches
Journals 8 1/2 inches by 12 inches

Wheel Base.

Driving	7 feet 6 inches
Rigid	15 feet
Total engine	27 feet 1 inch
Total Wheel Base of Engine and Tender.	51 ft. $\frac{3}{4}$ in.

Weight.

On drivers, about.....	85,850 pounds
On truck, ".....	40,200 pounds
On trailing wheels.....	33,000 pounds
Total engine ".....	159,050 pounds

Tender.

Diameter of wheels	42¼ inches
Journals	6¼ inches by 10 inches
Tank capacity	5,000 gallons

The Great Northern Railway elevator at West Superior, Wis., is to be the largest in the world. It will be built of steel at a cost of more than \$2,000,000, and the first contracts have already been let. The capacity is to be 6,500,000 bushels, or an increase of 2,500,000 more than the largest existing elevator. The date of completion is placed at the first of next year.

80,000-POUND, 35-FOOT, COAL CARS.

Lake Shore & Michigan Southern Ry.

Mr. A. M. Waitt, General Master Car Builder, Lake Shore & Michigan Southern Railway, has kindly furnished drawings of a new design for drop bottom coal cars of the gondola type for a capacity of 80,000 lbs.

The design follows the general lines adopted last year for cars of 60,000 lbs. capacity ("American Engineer," June, 1898, page 184), and a comparison of the two gives evidence of a systematic effort to secure the advantages of uniformity without, however, sacrificing important features for that purpose. The following are the general dimensions:

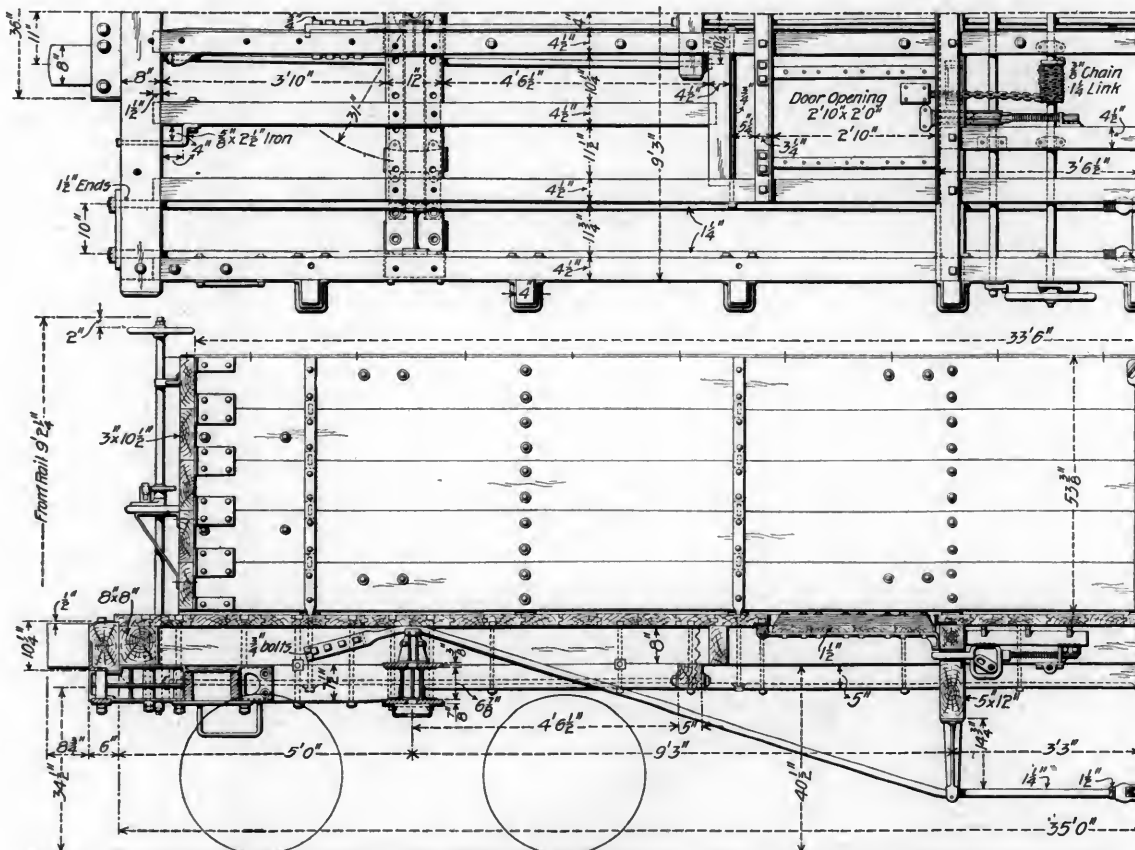
General Dimensions.			
Length, over end sills.....	35 ft.	0	in.
Length, inside of box.....	33 ft.	6	in.
Width, over side sills.....	9 ft.	3	in.
Width, inside of box.....	8 ft.	9	in.
Height, top of rail to top of box.....	8 ft.	6	in.
Height, over all.....	9 ft.	2	in.
Height to bottom of sills at ends.....	3 ft.	3	in.
Height of box, inside.....	4 ft.	5	in.
Door openings, length.....	2 ft.	10	in.
Door openings, width.....	2 ft.	0	in.

The sills are 8 in number. The side sills are $4\frac{1}{2}$ by 12 in., the same section as those for the 60,000 lbs. cars, and of yellow pine. The two center floor timbers, the two long intermediate floor timbers and the eight short intermediate floor timbers, including the short ones over the needle beams, are all $4\frac{1}{2}$ by 8 in. in section and all of yellow pine. The end sills are 8 by 8 in. of white oak and the two cross tie timbers are of the same material, 5 by 12 in. section. The wooden buffer blocks are of 6 by $10\frac{1}{4}$ in. white oak, carrying malleable iron buffers. The draft timbers are of 5 by $7\frac{1}{2}$ white oak abutting against 5 by 5 in. sub floor timbers forming a continuous system to sustain the compressive stresses. The draft gear is similar to that of the lighter cars in the arrangement for the pulling stresses, which are carried from the outside drawbar lugs by means of two rods to 5 by 5 inch white oak draft rod cross timbers, located

just outside of the drop doors, and these two timbers are connected by means of two one inch rods with ends enlarged to $1\frac{1}{4}$ in., lying between the center floor timbers, and therefore between the drop doors. The spacing of the floor timbers is shown in the plan view of the car, which also illustrates the construction of the drop door frames and the continuous draft connections.

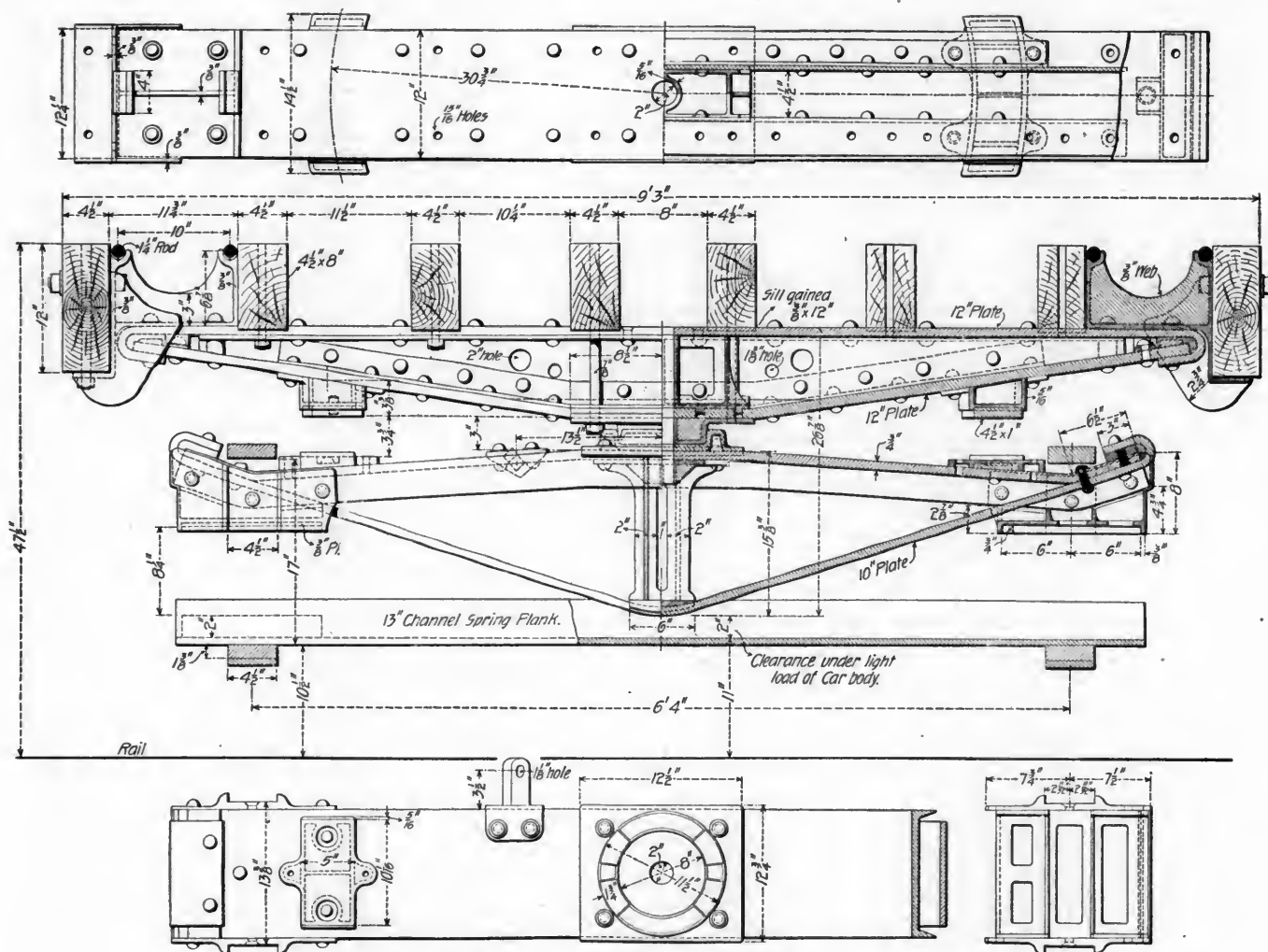
The body truss rods are six in number and are of $1\frac{1}{4}$ -in. iron enlarged to $1\frac{1}{2}$ in. at the ends and connected together at the center by wrought iron turnbuckles made by the Cleveland City Forge & Iron Co. The grouping of the rods is shown in the end and sectional views of the car. It is evident that they must be kept clear of the drop doors, which necessitated placing two of them at each side of the car, near the ends of the cross-tie timbers, while two others are placed at $5\frac{3}{4}$ -inch centers at the center of the car and between the center sills. The outside truss rods pass through the end sills over bracket castings supported on the ends of the bolsters and then under malleable iron bearings $14\frac{3}{4}$ inches deep below the bottom faces of the cross-tie timbers, which makes the depth of the truss $34\frac{3}{4}$ inches below the upper faces of the sills, and gives a good trussing effect for the load to be handled, with a low fiber stress on the rods. The inner truss rods are like the outer ones, except that at the ends, where, after passing over the malleable iron brackets, which rest on the top of the body bolster, they terminate in ends flattened to 1 by $2\frac{1}{2}$ -inch rectangular sections, 15 inches in length, with lips on the extreme ends, and these terminals are anchored to the inside faces of the center sills by means of $4\frac{3}{4}$ -inch bolts to each rod. To make this anchorage more secure a wrought iron plate by $\frac{1}{2}$ by $2\frac{1}{2}$ by $11\frac{1}{2}$ inches with a lip $\frac{1}{2}$ -inch deep is placed under each end of each rod.

The Gould M. C. B. standard coupler is used with the M. C. B. drawbar strap. The draft springs are double, the outside coil being $5\frac{1}{2}$ inches outside diameter and 8 inches high of $1\frac{1}{8}$ -inch bar, while the inner coil is $3\frac{1}{8}$ inches outside diameter and of $\frac{5}{8}$ -inch steel. The capacity of each double coil is about 16,000 pounds. The draft arms, also made by the Gould Coupler Co.,



80,000 Pound, 35 Foot Coal Cars.—Lake Shore & Michigan Southern Railway.

A. M. WAITT, General Master Car Builder.



80,000-Pound Coal Cars L. S. & M. S. Railway.
Simple Body and Truck Bolsters.

are malleable iron with palms at the bottoms to give room for two bolts in the attachment to the spring plank. The journal boxes are the M. C. B. standard for the same capacity and of the McCord type with malleable iron lids and Harrison dust guards. The boxes are packed with "Perfection Journal Box Packing."

The axles are the M. C. B. standard for 80,000-lb. cars. The specifications required open hearth steel having not to exceed 0.04 per cent. of phosphorus, 0.04 per cent. of sulphur, not more than 0.35 per cent. or less than 0.3 per cent. of carbon, and not more than 0.6 per cent. of manganese. The axles are to be tested under a drop of 1,640 lbs. with cast iron supports, having 6-inch bearing surfaces, spaced at 3 feet centers and must not crack or break under 5 blows from a height of 40 feet.

The wheels are 33 inches in diameter, weighing 650 lbs., and the wheel base of the truck is 5 feet 2 inches. The Lake Shore & Michigan Southern has ordered 500 of these cars and the Pittsburgh & Lake Erie has ordered the same number.

A NEW AND INTERESTING ENGLISH LOCOMOTIVE.

Lancashire & Yorkshire Railway.

In a new design of fast passenger locomotive, by Mr. J. A. F. Aspinall of the Lancashire & Yorkshire Railway, illustrated in "The Engineer," we find a number of interesting and novel improvements. This engine is noteworthy for the additional reason of being built up to the present limitations in regard to size; that is to say, no larger engine can be run on an English railroad. It is possible to extend the length, but not the

width or height. The engine may appear enormous, as compared with others in England, but it looks small enough when compared with the new Schenectady, fast mail engine on the Chicago & Northwestern, and the corresponding Baldwin engines for the Chicago, Burlington & Quincy.

The Lancashire & Yorkshire engine is the Atlantic type in regard to the wheels, but with inside cylinders 19 by 26 inches, and steam jacketed, the jacket supply of steam being apparently controlled from the cab. The Joy valve motion is used. The driving wheels are 87 inches in diameter. The boiler is 64 inches in diameter and unusually long, the tubes being 15 feet long. The heating surface is 2,052 square feet and the grate area 26 square feet. The smoke-box is extended and is unusually long, but the extension is to the rear, and the front tube sheet is carried back into the barrel of the boiler, a peculiar arrangement, probably used for the sake of appearance. The firebox has direct stays. The total height over the stack is 13 feet 5 1/2 inches, and the total width is 8 feet 8 inches.

The back head of the boiler is flanged outwards instead of inwards, and both ends of the rivets are exposed, which is very convenient for machine riveting. We note, also, a novelty in the driving spring rigging, the weight comes upon a bell crank under each driving box, and while the horizontal arms of these cranks transmit their loads to the spring, the vertical arms on each side are connected by a tension rod, which acts as an equalizer and is very much lighter in weight than our forms of equalizers.

The purpose of this design is to secure sufficient power in one engine to insure against the necessity for double-heading in providing for increased demands imposed by heavier cars.

LOCOMOTIVE DESIGN—THE WORKING STRENGTH OF MATERIALS.

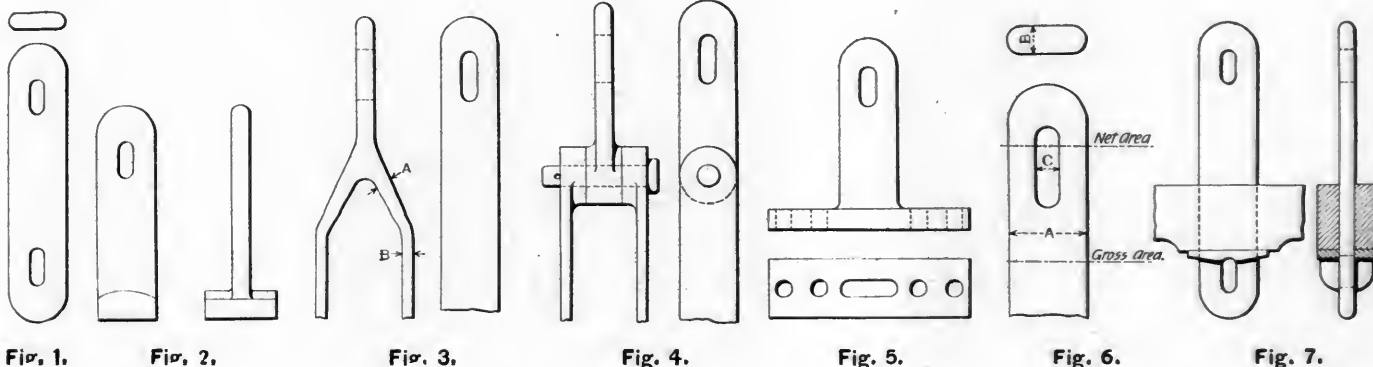
By F. J. Cole, Mechanical Engineer, Rogers' Locomotive Works.

Spring Hangers and Equalizers.

If a record is kept of the breakages of locomotive parts, where the number of engines in actual service on the railroad is sufficiently large to include all sorts, conditions and ages of locomotives, it will be found that the percentage of broken spring hangers and spring rigging is very large. No apology seems necessary for the following suggestions, and perhaps in some cases, elementary remarks regarding the strength of these parts, if they are the means of lessening, even in a small degree, the frequency of engine failures caused by the breakages of these parts.

cable to make all hangers straight, without some form of enlargement, fork or other device at the lower end.

The straight form is shown in Fig. 1, in which the strength of the material is not impaired in any way, the gibs at the top and bottom being free to move sideways, so that no side strain is apt to be produced, as the gibs rock in slots and preserve a center bearing. The form with a head on the lower end, shown in Fig. 2, is used when the clearance below the equalizer is limited. It is a convenient and customary style on account of its wide bearing on the lower end, not cutting into the equalizer face, and its suitability for use when the space is limited. In this style the iron may be injured in upsetting or the bearing not being uniform on both sides, causes a bending stress to occur, which is liable to start a crack at the shoulder. To straddle the frame, the forms shown in Figs. 3 and 4 are commonly used. The upper part of the fork at A should be made



A spring hanger is a simple thing, not at all complex in its design, manufacture or functions. The calculation of its size for the weight it has to carry is only the work of a few minutes, provided the working stress per square inch of section is known. Actual practice (deduced from breakage) indicates that the range of working stress is from 3,500 to 4,500 pounds per square inch for good wrought iron. The maximum 4,500 pounds should never be exceeded, if breakdowns and failures are to be prevented. For exceptionally good iron the higher figures, 4,500 pounds, may be used, but for ordinarily good material, to insure freedom from breakages, the stress should be limited to 4,000 pounds.

The theoretical reason for this low working stress is not entirely clear, although it can be partly accounted for by the fact that the static load is largely increased by impact caused by the vertical motion of the driving box and the jolting or uneven movement of the engine. This, however, is not felt in its full force, as it is conveyed or transmitted to the hangers through the elastic medium of the springs. With long half elliptic springs, composed of many narrow plates, there is a tendency to wear unevenly and bend the hangers sideways. This occurs when the engine has been in service for some time, the spring bands or the saddles wearing more on one side than the other, causing the spring rigging to be thrown out of line. But bearing in mind the fact that the impact, vibration or concussion is transferred through the springs, its effect must be greatly modified and reduced before the hangers are reached. If the pull on the hangers was always directly in line with their centers, a much higher stress could no doubt be used. The fact that spring hangers do not always, or in fact usually, break through the key ways indicates that some other force than that acting directly in line with their centers, bends or twists it and throws upon them an eccentric or side bending stress, causing their rupture at a comparatively low figure. In this connection it should be remembered that it is not usually practi-

much heavier than at B to prevent springing and breaking. The pin connection, Fig. 4, is a stronger construction, but more expensive to maintain on account of greater number of wearing parts. From Table No. 1 the proper size of spring hangers and equalizer posts may be selected. It is calculated for round-edged iron, the working stress being taken through the keyway slot for the minimum section.

TABLE NO. 1.

Showing the net area and working stresses of spring hangers and equalizer posts. Net area in the table is taken through the slot. The working stresses are based on the net area. The gross area is the sectional area without any deduction for the slot. See Fig. 6:

Size of hanger.		Width of slot.	Gross area.	Net area through slot.	Working stress.		
A	B	C			3,500 lbs.	4,000 lbs.	4,500 lbs.
Inches	Inches.	Inches.					
2	$\frac{5}{8}$	$\frac{3}{4}$	1.16	.77	2,690	3,060	3,460
$2\frac{1}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	1.33	.93	3,250	3,720	4,180
$2\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	1.47	1.00	3,500	4,000	4,500
$2\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	1.75	1.19	4,160	4,760	5,370
$2\frac{3}{4}$	$\frac{5}{8}$	$\frac{3}{4}$	1.66	1.19	4,160	4,760	5,350
$2\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	1.94	1.38	4,830	5,520	6,210
$2\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	2.24	1.59	5,500	6,360	7,150
3	$\frac{3}{4}$	$\frac{3}{4}$	2.13	1.57	5,490	6,280	7,060
3	$\frac{3}{4}$	$\frac{3}{4}$	2.46	1.80	6,300	7,200	8,100
$3\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	2.32	1.75	6,120	7,000	7,870
$3\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	2.68	2.03	7,100	8,120	9,130
$3\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	2.68	1.92	6,720	7,680	8,640
$3\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	2.50	1.94	6,790	7,760	8,730
$3\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	2.90	2.25	7,870	9,000	10,120
$3\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	3.12	2.47	8,640	9,880	11,110
4	$\frac{3}{4}$	$\frac{3}{4}$	3.33	2.57	8,990	10,280	11,560
4	1	1	3.78	2.78	9,730	11,120	12,510
$4\frac{1}{4}$	1	1	4.23	3.28	11,480	13,120	14,760
5	1	1	4.78	3.78	13,230	15,120	17,010
5	1	$1\frac{1}{4}$	4.78	3.53	12,350	14,120	15,880
$5\frac{1}{4}$	1	1	5.28	4.28	14,960	17,120	19,260
$5\frac{1}{4}$	1	$1\frac{1}{4}$	5.28	4.03	14,100	16,120	18,130
6	1	1	5.78	4.78	16,730	19,120	21,510
6	1	$1\frac{1}{4}$	5.78	4.53	15,850	18,120	20,380

The working loads given above are supposed to be the net weight resting upon the rails, less that of the wheels, axles, boxes and eccentrics.

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TABLE 2.—MODULUS OF SECTIONS, SOLID RECTANGULAR BEAMS, AXIS HORIZONTAL.

For center load $\frac{Wl}{4}$ or $\frac{1}{4} Wl$
For uniform load $\frac{Wl}{8}$ or $\frac{1}{8} Wl$

Depth.	Width.															
	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2
1	.02	.04	.06	.08	.10	.12	.14	.16	.18	.20	.22	.24	.26	.28	.30	.32
1 1/4	.03	.06	.10	.13	.16	.19	.23	.26	.29	.32	.36	.39	.42	.45	.49	.52
1 1/2	.05	.09	.14	.18	.23	.28	.32	.37	.42	.46	.51	.55	.60	.65	.69	.74
1 3/4	.06	.13	.19	.25	.32	.38	.43	.51	.57	.64	.70	.76	.83	.89	.94	1.0
2	.08	.16	.25	.33	.41	.49	.58	.66	.74	.82	.91	.99	1.07	1.15	1.24	1.32
2 1/4	.10	.21	.31	.42	.52	.63	.73	.84	.94	1.05	1.15	1.26	1.36	1.47	1.57	1.68
2 1/2	.13	.26	.39	.52	.65	.78	.91	1.04	1.17	1.30	1.43	1.56	1.69	1.82	1.95	2.08
2 3/4	.16	.31	.47	.63	.79	.94	1.10	1.26	1.42	1.57	1.73	1.89	2.05	2.20	2.36	2.52
3	.19	.37	.55	.75	.94	1.12	1.21	1.50	1.69	1.87	2.06	2.25	2.44	2.62	2.71	3.00
3 1/4	.22	.44	.66	.88	1.10	1.32	1.54	1.76	1.98	2.20	2.41	2.64	2.86	3.08	3.30	3.52
3 1/2	.25	.51	.76	1.02	1.27	1.53	1.78	2.04	2.29	2.55	2.80	3.06	3.31	3.57	3.82	4.08
3 3/4	.29	.58	.88	1.17	1.46	1.75	2.05	2.34	2.63	2.92	3.22	3.51	3.80	4.09	4.39	4.68
4	.33	.67	1.00	1.33	1.67	1.99	2.34	2.67	3.00	3.34	3.67	4.00	4.34	4.68	5.01	5.34
4 1/4	.38	.75	1.13	1.50	1.88	2.26	2.63	3.01	3.39	3.76	4.14	4.51	4.89	5.27	5.64	6.02
4 1/2	.42	.84	1.27	1.69	2.11	2.53	2.96	3.38	3.80	4.22	4.65	5.07	5.49	5.91	6.34	6.76
4 3/4	.47	.94	1.41	1.88	2.35	2.82	3.29	3.76	4.23	4.70	5.17	5.64	6.11	6.58	7.05	7.52
5	.52	1.04	1.56	2.08	2.60	3.13	3.65	4.17	4.69	5.21	5.73	6.25	6.77	7.30	7.82	8.34
5 1/4	.57	1.14	1.72	2.29	2.87	3.44	4.01	4.59	5.17	5.73	6.31	6.88	7.46	8.03	8.60	9.19
5 1/2	.63	1.26	1.89	2.52	3.15	3.78	4.41	5.04	5.67	6.30	6.93	7.56	8.19	8.82	9.45	10.08
5 3/4	.69	1.38	2.06	2.75	3.44	4.13	4.82	5.51	6.20	6.89	7.57	8.26	8.95	9.64	10.33	11.02
6	.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50	8.25	9.00	9.75	10.50	11.25	12.00
6 1/4	.81	1.63	2.44	3.25	4.06	4.88	5.69	6.51	7.32	8.14	8.95	9.76	10.57	11.39	12.20	13.02
6 1/2	.88	1.76	2.64	3.52	4.40	5.28	6.16	7.04	7.92	8.80	9.68	10.56	11.44	12.32	13.20	14.08
6 3/4	.95	1.90	2.84	3.79	4.74	5.69	6.64	7.59	8.54	9.48	10.43	11.38	12.33	13.28	14.23	15.18
7	1.02	2.04	3.06	4.08	5.10	6.12	7.14	8.16	9.18	10.20	11.22	12.24	13.26	14.28	15.30	16.32
7 1/4	1.09	2.19	3.28	4.38	5.47	6.57	7.66	8.76	9.85	10.95	12.04	13.14	14.23	15.33	16.42	17.52
7 1/2	1.17	2.34	3.51	4.68	5.85	7.03	8.20	9.37	10.54	11.71	12.88	14.05	15.22	16.40	17.57	18.74
7 3/4	1.25	2.50	3.75	5.00	6.25	7.50	8.75	10.01	11.26	12.51	13.76	15.01	16.26	17.51	18.77	20.02
8	1.33	2.66	3.99	5.33	6.65	7.99	9.32	10.66	11.99	13.32	14.65	15.99	17.31	18.64	19.99	21.32
8 1/4	1.41	2.83	4.25	5.67	7.08	8.50	9.92	11.34	12.75	14.17	15.59	17.01	18.39	19.84	21.26	22.68
8 1/2	1.50	3.01	4.51	6.02	7.52	9.03	10.53	12.04	13.54	15.05	16.54	18.06	19.56	21.07	22.57	24.08
8 3/4	1.59	3.19	4.78	6.38	7.97	9.57	11.16	12.76	14.35	15.95	17.54	19.14	20.73	22.33	23.92	25.52
9	1.68	3.37	5.06	6.75	8.40	10.12	11.81	13.50	15.18	16.87	18.56	20.25	21.90	23.62	25.31	27.00
9 1/4	1.78	3.56	5.34	7.13	8.91	10.69	12.48	14.26	16.04	17.82	19.60	21.39	23.17	24.95	26.74	28.52
9 1/2	1.88	3.76	5.64	7.52	9.40	11.28	13.16	15.04	16.92	18.80	20.68	22.56	24.44	26.32	28.20	30.08
9 3/4	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82	19.80	21.78	23.76	25.74	27.72	29.70	31.68
10	2.08	4.16	6.24	8.33	10.41	12.48	14.57	16.66	18.74	20.82	22.90	24.99	27.07	29.14	31.23	33.33

Formerly nearly all locomotives were built with the form of equalizer post or fulcrum, shown in Fig. 5. This answered very well for light engines, four 1-inch or 1 1/2-inch bolts being sufficiently strong, so that little or no trouble was experienced with moderate loads. Owing to the comparative lightness, allowing the foot to bend or spring slightly, the two center bolts must evidently hold most of the weight. With heavy engines this form is the source of continual trouble from the bolts working loose and breaking. Slotting the frame and running the post through is a much better construction. See Fig. 7. Usually the frame is made deeper at the slot and protected from undue wear by a steel plate. The full strength of the material is utilized in this form with no chance of failure from imperfect

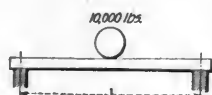


Fig. 8.



Fig. 9.



Fig. 10.

welds, upsetting or other sources of possible impairment of strength.

Equalizer fulcrums should be proportioned for a working stress of 4,000 to 4,500 pounds per square inch. The equalizing beams connecting the springs together, when made of good hammered wrought iron or mild steel, should be calculated for 10,000 pounds to 12,000 maximum fiber stress. When made of first-class hammered iron they do not seem in practice to break in the center when the load equals 15,000 pounds per square inch, although the liability to bend or deflect too much might be an objection. It may be noted in this connection that the effects of impact should apparently be as noticeable in the beams as in the hangers uniting the springs to the beams, and require a correspondingly low working fiber stress. This, however, is not borne out by breakages of the parts in use, and the figures given (10,000 to 12,000 pounds per square inch) represent what is known to be good practice.

Nearly all equalizers are beams supported at the center and loaded with single uniform loads at either end, as in Fig. 9. This evidently is the same method of loading as the more fa-

miliar one, Fig. 8, of a beam supported at each end with a single center load, equal to both the loads in the first instance.

To determine the strength of beams of various sections to resist bending for different methods of loading:

Let l = length in inches.

h = depth in inches.

b = width in inches.

R = section modulus.

W = load in pounds.

S = maximum fiber stress per square inch.

M = bending moment in inch pounds = Wl or $\frac{Wab}{l}$.

I = moment of inertia of section.

$$R = \frac{bh^2}{6} \text{ solid rectangles.}$$

$$I = \frac{bh^3}{12} = R = \frac{I}{\frac{1}{2}h}$$

(1) Fixed at one end—Single load Fig. 10. $S = \frac{M}{R}$.

(2) Supported at both ends—Single center load Fig. 8.

$$S = \frac{M}{4R}$$

(3) Supported at both ends—Distributed load Fig. 11.

$$S = \frac{M}{8R}$$

(4) Supported at both ends—Single load at any point Fig. 12.

$$S = \frac{Wab}{R}$$

(5) Supported at both ends—Two equal loads at any point

$$\text{Fig. 13. } S = \frac{\frac{1}{2}Wa}{R}$$

(Half of sum of both loads.)

To determine the maximum stress S per square inch for the ordinary type of equalizer, Fig. 14, length, load, height and width being given, considered as a beam supported at both ends and loaded in the center:

$$S = \frac{Wl}{4R}$$

For a given stress, length, depth and breadth, to determine the load W :

$$W = \frac{RS^4}{l}$$

For a given stress, length, load and breadth to determine the depth h :

$$h = \sqrt[3]{\frac{1}{b} \frac{Wl}{S^4}}$$

For a given stress, length and load to determine from Table No. 2 the modulus of section "R" required:

$$R = \frac{Wl}{S^4}$$

From Table No. 2 may be found the modulus of section "R"

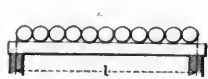


Fig. 11.

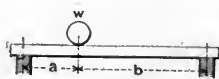


Fig. 12.

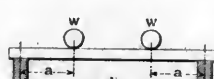


Fig. 13.

for any depth of beam from 1 to 10 inches, varying by $\frac{1}{4}$ inches and widths from $\frac{1}{8}$ to 2 inches, varying by $\frac{1}{8}$ inches. Maximum fiber stress per square inch $= \frac{M}{R}$. For different methods of supporting and loading, the value of "M" is given below:

(1) For a single concentrated load, beam fixed at one end, Fig. 10. $M = Wl$.

(2) For a single load concentrated at the center, beam supported at both ends, Fig. 8. $M = \frac{Wl}{4}$.

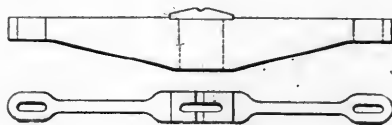


Fig. 14.

(3) For a distributed load, beam supported at both ends, Fig. 11. $M = \frac{Wl^2}{8}$.

$$11. M = \frac{Wl^2}{8}$$

(4) For a single load concentrated at any point, beam supported at both ends, Fig. 12. $M = \frac{Wab}{l}$, which may be substituted for Wl in the preceding formulae.

(5) For two symmetrical loads at two points, beam supported at both ends, Fig. 13. $M = \frac{1}{2} Wa$.

In addition to their being well designed and of sufficiently large sectional area to sustain the weight of the engine without exceeding the suggested fibre stress, the parts under discussion should be made of only the best quality of material. Wrought iron for this purpose should have a tensile strength of not less than 48,000 pounds per square inch, with an elongation of not less than 25 per cent. in eight inches. So comparatively small is the amount of material required to make the spring hangers for an engine that the additional cost of the best iron for this purpose is but trifling.

Application blanks for employment have been sent out to alumni of the Massachusetts Institute of Technology for the purpose of enabling the Secretary to facilitate communication between graduates available for employment and persons desiring to employ them. While not all will use them, the plan offers opportunities for those who desire to change their business connections to do so. The blanks provide for statements of experience. They are kept on file for one year and are used by the Secretary in answering applications for young men. Such a systematic way of carrying out the employment bureau function of technical schools is heartily commended, especially in view of the present extraordinary industrial activity.

PHOSPHOR BRONZE—A DESCRIPTION OF ITS CHARACTERISTICS AND METHODS OF MANUFACTURE.

By L. L. Smith.

Phosphor bronze is an alloy consisting primarily of copper and tin, to which phosphorus has been added as a deoxidizing agent. The action of phosphorus in this capacity will presently be considered at length. Phosphor bronzes for bearing purposes contain lead in addition to the copper, tin and phosphorus. Whether or not lead is introduced into the composition depends upon the character of service for which the alloy is intended.

The classification of phosphor bronzes of commerce may be made by dividing them into two general classes and designating them as high tensile bronzes and bearing bronzes. The former class is made up of alloys suitable for tubes, wire, springs, screws, etc., and for castings subjected to severe stress. For these purposes high tensile strength, toughness and resilience are required. The latter class includes alloys suitable for bearing parts of machinery, and may contain from 5 per cent. to 10 per cent. of lead. The lead, while greatly improving the bearing qualities, detracts materially from the tensile strength and toughness of the alloys. These latter qualities, however, are not of prime importance in the ordinary bearing and may readily be sacrificed in order to obtain a cool running, satisfactory bearing.

History of Manufacture.

The history of phosphor bronze manufacture extends back over several decades, for the use of phosphorus in bronze is by no means a recent discovery. As early as 1858, it was observed that the addition of a small quantity of phosphorus to copper and tin during the melting exerted a very beneficial influence on the bronze, by increasing its toughness and tensile strength, and by producing greater homogeneity throughout the mass of the alloy. The use of phosphorus in copper-tin alloys was continued to a limited extent, but it was not until some ten years later that phosphor bronze was exploited on a commercial scale by Messrs. Montefiore and Kuenzel, of Liege. In the manufacture of bronzes of high tensile strength, phosphorus as a deoxidizing and improving agent, became such a recognized success that its use in a similar capacity for bearing bronzes soon followed.

The use of phosphor bronze for locomotive bearings has been so generally adopted that at the present time it may almost be regarded as the standard bearing alloy in American railway practice. The results of investigations by Dr. C. B. Dudley of bearing metals on the Pennsylvania Railroad have undoubtedly had much to do with the general adoption of phosphor bronze as a railway bearing alloy. Dr. Dudley's investigations, published in the Journal of the Franklin Institute, Feb. and Mar., 1892, demonstrated by comparative trials of various bearing alloys, the superior qualities of phosphor bronze.

Composition and Specifications.

The composition of Pennsylvania Railroad Standard Phosphor Bronze, as published by Dr. Dudley, and which, with slight variations, has been generally adopted by other railroads, is as follows:

Copper, 79.7.

Tin, 10.0.

Lead, 9.5.

Phosphorus, .8.

The practice of the Chicago, Burlington & Quincy Railroad is represented by the following recent specification:

"1. Phosphor bronze must have the following composition in borings taken from any ingot or casting in the lot:

Copper not less than 77% nor more than 81%.

Tin not less than 9% nor more than 11%.

Lead not less than 9% nor more than 11%.

Phosphorus not less than 0.7 nor more than 1%.

"2. Ingots must have a concave or shrunken surface on the upper or open side.

"3. Castings must be free from blow holes and porosity; their fracture must show an even appearance and must be entirely free from oxides and dirt.

"4. Material failing these requirements will be rejected."

Action of Phosphorus in Bronze.

In order to understand the action of phosphorus in the manufacture of bronzes, one must take into consideration the characteristics of their principal component, copper. Copper in its molten state exhibits a strong affinity for oxygen. If a

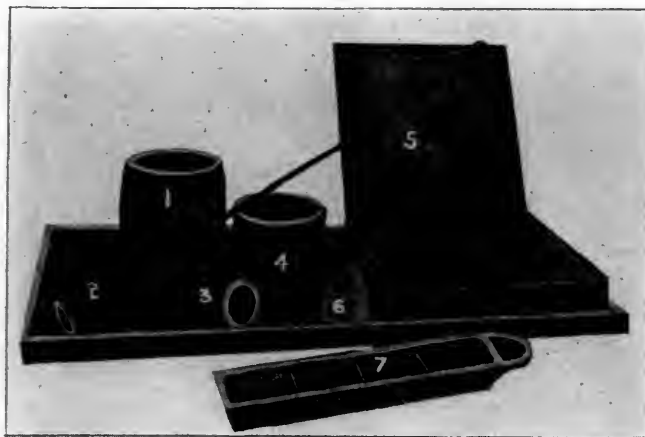


Fig. 1.



Fig. 2.

crucible of molten copper be exposed to the atmosphere without having over its surface a layer of charcoal, glass or other protective covering, the metal will absorb oxygen from the air. Also oxides of copper, if opportunity is afforded, are readily taken into solution by the molten copper. Oxygen, when present in an alloy of copper, is extremely prejudicial to satisfactory results when a uniformly strong, tough structural bronze or a homogeneous cool running bearing is desired. When the alloy having absorbed oxygen is cast, the copper oxide segregates near the upper surface of the ingot or the casting, in a discolored mass, which, on account of its black, greenish or reddish appearance, is visible in the fracture when the casting is broken. These spots will be a source of weakness if strength is desired, or will form hard spots of poor bearing qualities if a good bearing is wanted. In the ordinary course of events, in the manufacture of bronze it is almost impossible to prevent copper from absorbing some oxygen; therefore, in order to get rid of the oxygen, recourse is had to the use of some flux or deoxidizing agent. This flux, uniting with such oxygen as may be present, forms a constituent of a slag, which, separating out and rising to the top, leaves the alloy free from oxygen and renders possible the production of sound castings of homogeneous structure. Various fluxes for bronzes have been successfully used, among which are phosphorus, manganese, silicon, zinc and aluminum, each having its especial peculiarities, advantages and disadvantages. However inter-

esting these may be, our consideration will be confined to the first mentioned of these; viz., phosphorus.

Phosphorus is a non-metallic substance, and is known to commerce in two forms, red phosphorus and yellow phosphorus. These two forms, while identical chemically, are widely different in physical appearance and behavior. Yellow stick phosphorus is the form chiefly employed for bronzes. Stick phosphorus is translucent, yellowish white in color, and of a waxy consistency; not unlike a tallow candle in weight and general appearance. The sticks are cylindrical, about 9-16 inch in diameter and 11 inches long. The material is received

from the manufacturers in sealed tin cans, each containing about fifty sticks immersed in water. As above noted the function of the phosphorus in the bronze is that of a cleansing agent rather than as a vital element in its fundamental make-up. In fact a large excess of phosphorus over the amount needed to deoxidize the alloy is in most cases undesirable. The effect of excess phosphorus upon the physical qualities of bronze is, to increase the hardness at the expense of toughness and malleability, furthermore it lowers the melting point. Excellent bronzes for certain purposes may contain only a trace of phosphorus. For parts requiring strength or toughness, chemical analysis should not show to exceed 0.2 or 0.3 per cent., and for bearing parts not to exceed 0.8 per cent. to 1 per cent. The fracture of a phosphor bronze casting intended for bearing purposes should



Fig. 3.

present a close grained, uniform, mouse-colored appearance, free from segregation and discolored oxide spots.

Foundry Treatment of the Alloy.

To obtain proper results with phosphor bronze, care must be taken with its manipulation in the foundry. Even with the best materials in correct proportions, unless care and judgment are exercised in the foundry treatment, the product will be unsatisfactory, and perhaps even unfit for use. In this connection it may be remarked that the proper heat of pouring phosphor bronze is of the highest importance. Before pouring, the alloy should be cooled down almost to the temperature at which it begins to solidify. If poured too hot, a segregation of components will result. If such a hot poured casting be broken, the mottled appearance of the fracture will plainly show the segregation which has taken place. In fact, with bronzes in general the appearance of a freshly made fracture furnishes an excellent medium for judging the qualities and properties of the alloys.

Methods of Introducing Phosphorus.

The methods of introducing phosphorus into a bronze are quite numerous, but the following are three most commonly used: 1st. By adding stick phosphorus direct into the crucible of molten bronze. 2d. By adding to the other bronze constituents, phosphor-tin consisting of about 95 per cent. tin and 5 per cent. phosphorus. 3d. By adding phosphor-copper consisting of from 5 per cent. to 7 per cent. phosphorus, the balance being copper.

Our attention will be confined chiefly to the last mentioned method and to a detailed description of the preparation of the phosphor copper. Phosphor copper is frequently made containing 8 or 10 per cent. of tin, and in such cases the material is known to

the trade as "hardener" or "hardening." The reason that tin is made a constituent of hardener is, that in the case a bronze contains tin and copper, say, in the proportion of 1 to 8, the hardener also containing tin and copper in the same proportion may be added to the bronze in any desired quantity without disturbing the relative proportions of the constituent materials.

The Manufacture of Hardener.

Fig. 1 shows the appliances necessary for the manufacture of the hardener as follows: 1. An ordinary graphite crucible such as is used in melting of brass and bronze. 2. A cup-shaped graphite phosphorizer. 3. Same as 2, without the iron handle. It is here photographed to show more clearly its form. 4. A 3-gallon earthenware jar for holding copper sulphate solution. 5. A galvanized iron pan 6 inches deep. Suspended across the pan near the top is a heavy wire netting—the pan is provided with a hinged lid shown closed in Fig. 2. 6. A respirator consisting of a soft rubber case, containing a wet sponge—this respirator is worn over the mouth and nose of the workman to protect his respiratory organs from the disagreeable fumes of anhydrous phosphoric acid generated during the phosphorizing process. 7. An ingot mold into which the hardener is poured into cakes about $4 \times 6 \times \frac{3}{4}$ inches. Fig. 2 shows the materials required. 1. A can of stick phosphorus. 2. Ingot copper. 3. Block tin cut into pieces of convenient size. 4. A box of copper sulphate.

In preparing the hardener, 142 pounds of copper are melted under charcoal in a crucible, and 17 pounds of tin are added. The phosphorus sticks are broken in two and placed in a weak solution of copper sulphate in the earthen jar. The phosphorus reduces copper from the solution and a coating of metallic copper is deposited on the surface of the stick phosphorus, preventing its too ready ignition when exposed to the air. The portion of the pan below the netting is partly filled with water for the purpose of keeping the contents cool. Over the netting is spread a sheet of blotting paper on which the copper coated sticks of phosphorus are allowed to dry. This being accomplished, the pot of metal is pulled out of the furnace, and one workman stands with the phosphorizer somewhat in the manner indicated in Fig. 3; a second workman with his hands protected by gloves grasps four sticks of phosphorus, and by a dexterous movement throws them into the cup-shaped phosphorizer, which is immediately plunged into molten metal. After a half minute or so the phosphorus is absorbed by the molten metal, then another charge is delivered, and so on until 11 pounds of phosphorus have been charged. The hardener is then poured out into cakes as before described. During the phosphorizing process dense fumes of phosphoric acid are given off, but the amount in weight of phosphorus so lost is comparatively trifling.

The hardener thus produced, according to analysis, contains 6 per cent. of phosphorus. This large percentage of phosphorus lowers the melting point of the material to such an extent that it solidifies only on cooling to a very dark red or almost black heat. A cake of hardener, when broken, presents a bright metallic fracture of a steel gray color, notwithstanding copper enters into its composition to the extent of 83 per cent.

Having the hardener at hand, the making of phosphor bronze consists merely of charging into a crucible in proper proportions copper, tin, hardener and lead (if required), melting and pouring at a proper heat.

A 100-horse power engine operated for about 60 cents per day for fuel expenses, appears to be an extravagant promise. This is the claim recently made for a gas engine, and producer gas where fine anthracite coal is used. If not at present possible, it is worth working for.

The University of Illinois has established a course in Railway Engineering, to be opened in September of the current year. The department will be under the charge of Prof. L. P. Breckenridge.

COMPOUND LOCOMOTIVES ON THE NORTHERN PACIFIC RAILWAY.

The records of compound and simple locomotives on the Northern Pacific, made the subject of a paper by Mr. E. M. Herr before the Western Railway Club, are believed to offer the most valuable information of this kind which has appeared. They apparently establish the compound upon a satisfactory basis, when the details of design and construction are properly carried out, and they support the opinion which has often been expressed in these columns, that when a compound is designed so that it will not break down on the road, and when it is made powerful enough to do the required work, it will be considered a satisfactory type, and it will be used on account of the saving in fuel.

Mr. Herr's paper should have the most careful attention of motive power and operating officers for four reasons, the first being the favorable showing made by compounds and the second being the admirable treatment of the important subject of distributing locomotives in accordance with their adaptability to meet the special and peculiar conditions of particular divisions. The third is the value of heavy and powerful engines, while the fourth is the wastefulness of delayed trains.

The use of compounds on this road has been extensive and intelligent. The new designs were made with unusual care, and the engines were not petted, but were put to hard work. That they were not "babied" is seen in the fact that one of the passenger engines ran more than 108,000 miles in twelve months, and this without coming into the shops for repairs. The systems of compounding represented were the Vauclain, the Richmond, the Pittsburgh and Schenectady. The sizes and types ranged from a mogul weighing 85,000 pounds on the drivers, and with 19 and 27 by 24-inch cylinders, to a mountain mastodon engine with 150,000 pounds on the drivers and with cylinders 23 and 34 by 30 inches. All of the records were kept in terms of 1,000-ton miles, the cost of repairs being stated also in engine miles.

No particular compound gave results that were universally better than the others, but it was found that one which was never worked with live steam in the low-pressure cylinder gave the highest average. This engine had the great disadvantage of stalling and found little favor with the operating department on this account. Herein is an important matter of design, because no engine can be a success if unsatisfactory in hauling capacity. A compound that is lacking in power when run as a compound and yet can not be converted, on occasion, into a simple engine, must be unpopular, although its coal record per mile run may be relatively high.

The freight compounds gave the best results on the division where they were fully loaded in both directions, averaging 28.4 per cent. over the simple engines of the same class carrying 180 pounds steam pressure and 35.7 per cent. over lighter simple engines having 150 pounds steam pressure. These compounds were capable of hauling heavy trains, and this is the secret of their remarkable success in this case. The passenger compound ran 273 miles continuously with trains weighing about 500 tons, and sometimes 550 tons, and in only two months out of 14 covered by the record, did the compound fail to show superior economy. In these cases it was found that the compound was handicapped by delayed trains and making up the time, combined with bad weather, accounted for the failure to show good results in those two months. During another month the conditions were reversed and the compound was favored to an equal extent. The average gain in economy from compounding in passenger service was 14.6 per cent. This was unusually heavy service, however, which is favorable to this type, and on the other hand the later records were taken after the compound had made more than 100,000 miles and the simple 90,000 miles.

The repairs to the compounds seem to be no more, and they are certainly not less than those of the simples. This is a favorable showing, but it is probable that with longer service

the cost of repairs will increase rather faster for the compound than for the simple engine. In the case of these passenger engines the conditions were severe enough for a thorough test of the compound, because both engines were always double and often triple crewed, the mileage of the compound was greater than that of the simple, and yet the repairs were practically the same.

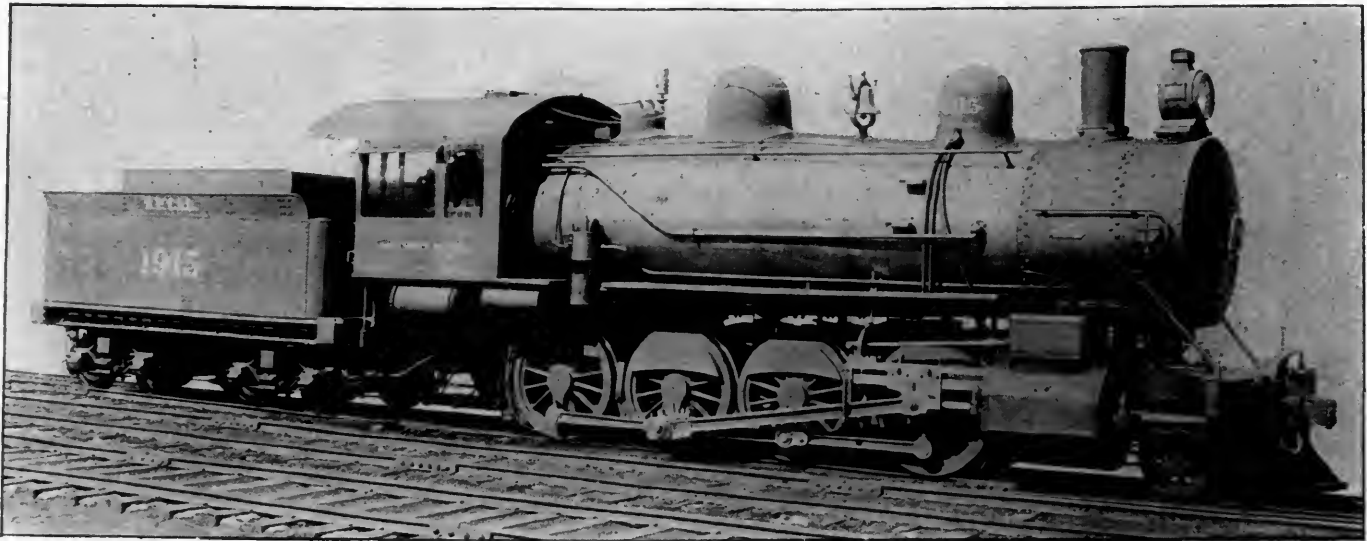
The great importance of using the compounds where they may work to the best advantage is seen in the record of the Vauclain compound in the heavy mountain service, for which the design was best adapted. This engine was a consolidation Baldwin, simple, converted into a compound with cylinders 15 and 25 by 28 inches, and weighing 138,000 pounds on drivers and having 180 pounds steam pressure. This engine, considering the lighter train hauled, gave better steam economy than the heavy mastodon compound of the two cylinder type with cylinders 23 and 34 by 30 inches, weighing 150,000 pounds on drivers and carrying 200 pounds steam pressure. The four-

CONSOLIDATION AND MOGUL LOCOMOTIVES.

SOUTHERN PACIFIC COMPANY.

Compound Consolidation.

The Schenectady Locomotive Works have just delivered six very heavy compound locomotives of the two-cylinder type to the Southern Pacific Company for freight service on the heavy grades of that road in California. These are the most powerful two-cylinder compounds of which we have record. The cylinders are 23 and 35 inches in diameter and 34 inches stroke. These may be compared with the mastodon Schenectady compounds of the Northern Pacific, with cylinders 23 and 34 by 30 inches, with the Baldwin two-cylinder compounds for the Norfolk & Western, with cylinders 23 and 35 by 32 inches, with the Schenectady mastodon compounds for the Southern Pacific, with cylinders 23 and 35 by 32 inches, and also with the Northern Pacific Class Y consolidation engines, with cylinders 23 and



Compound Consolidation Locomotive—Southern Pacific Railway.

SCHENECTADY LOCOMOTIVE WORKS, Builders.

H. J. SMALL, Superintendent of Motive Power.

cylinder engine showed better economy than the two-cylinder type in the mountain service and not in the road service, because when worked at nearly full stroke the ratio of expansion in the two-cylinder is not sufficient to use the steam as economically as in the use of the four cylinder type. This fact has an important bearing on the expansion ratio of mountain pushing locomotives.

The Northern Pacific method of taking up the compound is commendable. It is such as to develop the question thoroughly and the results seem to be as follows: The compound is more economical than the simple engine. If well designed, it does not break down on the road and the running repairs need not be more expensive than those of simple engines. The compound features are not those which generally give the most trouble, but other parts which are common to both simple and compound engines and require to be designed with special care in the compound. The compound works most favorably a division where the work is nearly constant in both directions. Four-cylinder compounds work very favorably on heavy mountain grades where engines of whatever type are worked "full stroke." The speed of trains has a very important effect upon the economy of the compound.

It is believed that this excellent paper will exert a very important influence on the future of the compound locomotive. The opinions are expressed with calmness and intelligence and without prejudice. The period of observation was sufficiently long and the service was very exacting. The only question remaining is what the records will be after five or ten years of service.

34 by 34 inches. These heavy engines are all working under 200 pounds steam pressure, except the design we are now describing, which is using 220 pounds. The boiler sheets are unusually thick, as will be seen by the table of dimensions. This high pressure and the large heating surface, 3,027 square feet, with the larger cylinder capacity, form a remarkably powerful combination, and we are informed that the engines are giving excellent results, both in fuel economy and in power developed.

The weight on driving wheels is 173,000 pounds, which is, we believe, the greatest weight used in what are generally termed "road engines." The power of this engine may be profitably compared with the mastodon type shown on page 26 of our January, 1899, issue. The more advantageous arrangement of carrying the weight in the consolidation design is at once apparent. We shall not give space now to a discussion of these interesting subjects, but we desire to note the rapid advances that are being made in the power of freight locomotives. The chief dimensions are as follows:

General Dimensions.

Gauge	4 feet 8½ inches
Fuel	Bituminous coal
Weight in working order.....	193,000 pounds
Weight on drivers.....	173,000 pounds
Wheel base, driving.....	15 feet 8 inches
" " rigid	15 feet 8 inches
" " total	24 feet 4 inches

Cylinders.

Diameter of cylinders.....	23 and 35 inches
Stroke of piston.....	34 inches
Horizontal thickness of piston.....	5½ and 4¾ inches
Diameter of piston rod.....	3¾ inches
Kind	packing Cast iron

Size of steam ports .H. P., 20 inches x 1½ inches; L. P., 23 x 2½ inches
 " " exhaust " ..H. P., 20 inches x 3 inches; L. P., 23 x 3 inches
 " " bridges1½ inches

Valves.

Kind of slide valves.....Allen-American
 Greatest travel of slide valves.....6 inches
 Outside lap " " "H. P., 1½ inches; L. P., 1 inch
 Inside " " "¼ inch
 Lead of valves in full gear.....1/16 inch

Wheels, Etc.

Diameter of driving wheels outside of tire.....57 inches
 Material " centersCast steel
 Driving box materialCast steel
 Diameter and length of driving journals.....9 inches dia. x 12 inches
 " " main crank pin journals, 6½ inches dia. x 6 inches
 " " side rod crank pin journals, F. and B. 5 x 3¼ inches Inter. 5½ inches dia. x 4½ inches
 Engine truck journals.....6 inches dia. x 10 inches
 Diameter of engine truck wheels.....30 inches
 Kind " " "Krupp No. 3 steel tire

Boiler.

StyleExtended wagon top
 Outside diameter of first ring.....72 inches
 Working pressure220 pounds

Simple Mogul Locomotives.

The second engraving illustrates one of a lot of 12 simple mogul engines furnished by the same builders, of which the following table gives the chief characteristics:

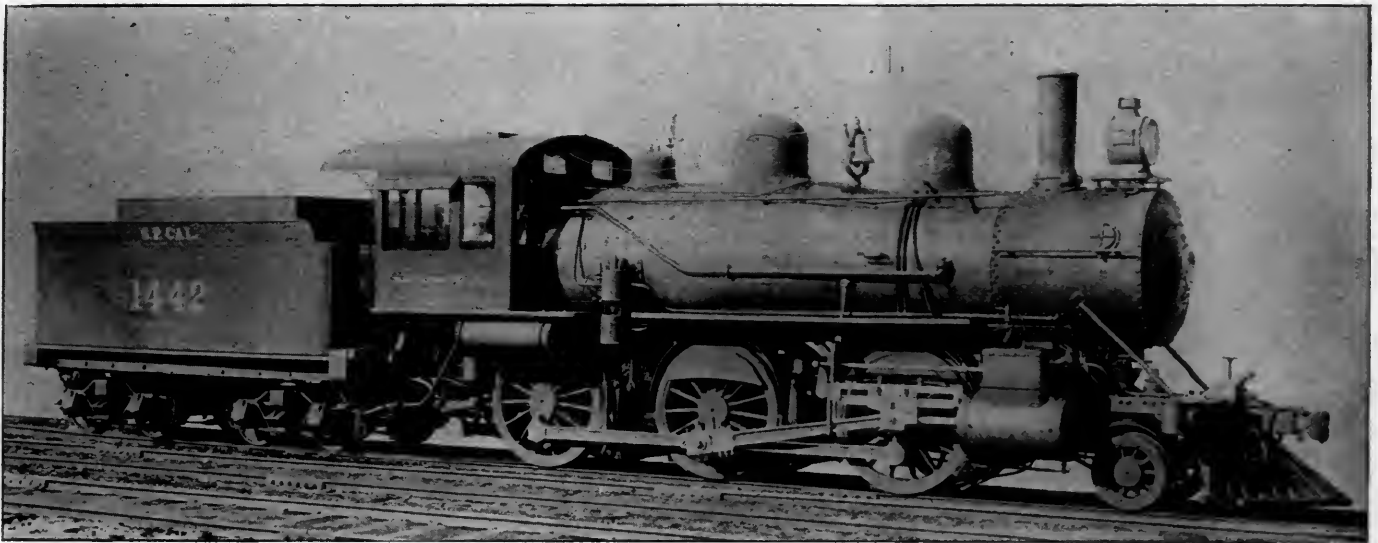
Gauge4 feet 8½ inches
 FuelBituminous coal
 Weight in working order.....142,600 pounds
 " on drivers123,700 pounds
 Wheel base, driving.....15 feet 2 inches
 " " rigid15 feet 2 inches
 " " total23 feet 3 inches
 " " of engine and tender.....46 feet 8½ inches

Cylinders.

Diameter of cylinders.....20 inches
 Stroke of piston.....28 inches
 Horizontal thickness of piston.....5¼ inches
 Diameter of piston rod.....3½ inches
 Kind of piston packing.....Cast iron rings
 Size of steam ports.....18 inches x 1½ inches
 " " exhaust "18 inches x 3 inches
 " " bridges1½ inches

Valves.

Kind of slide valves.....Allen-American



Simple Mogul Locomotive—Souther Pacific Railway.

SCHENECTADY LOCOMOTIVE WORKS, Builders.

H. J. SMALL, Superintendent of Motive Power.

Material of barrel and outside of fire-box.....Carbon steel
 Thickness of plates in barrel and outside of fire-box, 13/16, ¾, 9/16, 7/8 inches
 Fire-box, length.....126 inches
 " " width40½ inches
 " " depthF. 77 B. 73½ inches
 " " materialCarbon steel
 " " plates, thickness, sides, 5/16 inch; back, 5/16 inch; crown, ¾ inch; tube sheet, 9/16 inch
 Fire-box, water space, front, 4½ inches; sides, 3½ inches to 4 inches; back, 3½ inches to 4½ inches
 Fire-box, crown staying.....Radial 1½ inches diameter
 stay bolts1 inch diameter
 Tubes, material.....Charcoal iron No. 12
 " number of332
 " diameter2½ inches
 " length over tube sheets.....14 feet 6 inches
 Fire brick, supported on.....Studs
 Heating surface, tubes.....2817.30 square feet
 " " fire-box210.50 square feet
 " " total3027.80 square feet
 Grate "35.3 square feet
 " StyleRocking
 Ash panHopper, worked by air dampers front and back
 Exhaust pipesSingle
 " nozzles5¼ inches, 5½ inches and 5¾ inches dia.
 Smoke stack, inside diameter.....18 inches at top, 16 inches near bottom
 " top above rail.....14 feet 11½ inches
 Boiler supplied by two injectors.....Monitor No. 10

Tender.

Weight, empty33,200 pounds
 Wheels, number of.....8
 " diameter33 inches
 Journals, diameter and length.....4½ inches dia. x 8 inches
 Wheel base15 feet ¼ inches
 Tender frame10 inches steel channels
 " trucks, 2-4 whl. channel iron cen. bearing F. & B. side bearings on back truck
 Water capacity4,000 United States gallons
 Coal9 tons
 Total wheel base of engine and tender.....51 feet ¾ inch

These engines have the Westinghouse air brake and also the Sweeney brake arrangement on the left cylinder and Le Chatelier water brake on the low pressure cylinder.

Greatest travel of slide valves.....6 inches
 Outside lap " " "1 inch
 Inside " " "1/32 inch
 Lead of valves in full gearLine and line

Wheels, Etc.

Diameter of driving wheels outside of tire.....63 inches
 Material " centersCast steel
 Tire held byShrinkage
 Driving box material.....Cast steel
 Diameter and length of driving journals.....9 inches dia. x 12 inches
 " " main crank pin journals, 6 inches dia. x 6 inches
 " " side rod crank pin journals, main side 5¼ inches x 6½ inches, 5 inches dia. x 3½ inches
 Engine truck, kind.....2 wheel swing bolster
 journals6 inches dia. x 10 inches
 Diameter of engine truck wheels.....30 inches
 Kind " " "Krupp steel tired

Boiler.

StyleExtended wagon top
 Outside diameter of first ring.....62 inches
 Working pressure190 pounds
 Material of barrel and outside of firebox.....Carbon steel
 Thickness of plates in barrel and outside of firebox, 9/16, ½, 5/8, 11/16 inches
 Firebox, length108½ inches
 " " width40½ inches
 " " depthF., 73 inches; B., 59½ inches
 " " materialCarbon steel
 " " plates, thickness, sides, 5/8 inches; back, 5/8 inches; crown, ¾ inches; tube sheet, 9/16 inch.
 Firebox, water space, front, 4 inches; sides, 3½ inches; back, 3½ inches
 " " crown stayingRadial, 1 inch diameter
 stay bolts.....¾ inches and 1 inch diameter
 Tubes, material.....Charcoal iron, No. 12 B. W. G.
 " number of312
 " diameter2 inches
 " length over tube sheets.....12 feet
 Fire brick, supported on.....Studs
 Heating surface, tubes.....1946.7 square feet
 " " firebox168.0 square feet
 " " total2,114.7 square feet
 Grate "30.22 square feet

play, with the distances between tires they also give; furthermore, they will ride very badly.

Do you think an engine with 62 inch drivers and 30 inch stroke will have less piston speed than one with 50 inch drivers and 24 inch stroke? I do not think so; neither do I think it good practice to use an engine of this class in passenger service.

Do you think an engine ever reaches 25 or 30 per cent. of weight on drivers for available adhesion? I have never seen one get more than 20 to 22 per cent. with best dry rail or with sand. Do you think by increasing the cylinder capacity (as you say concerning the Pittsburgh engine, 23 to 23¾ inches diameter) there is less liability to slip? I do not, at least with the same pressure, weight and size of wheel. There would be more liability to slip, and I don't think the palm of power should be given the Lehigh Valley engines, as in fact they are more "over cylindered" than the Pittsburgh engine.

The fact of the matter is that the engines of to-day are not or do not show such a vast difference from those of years ago, as the ratio between tractive power and available adhesion is not so different. With the increase of weight also came the increase of boiler pressure and diameter of cylinders (and in some instances a decrease in diameter of drivers) in good proportion to the increase of weight on drivers.

Watertown, N. Y., April 4, 1899.

F. W. NAGLE.

[Our correspondent seems to be laboring under some misapprehensions concerning the heavy locomotives illustrated in our April issue. Referring to the matter of lateral motion, we do not care to criticise the practice, as there are no doubt good reasons for the amount given. There are too many apparent advantages in the all-flanged tires to be wholly offset by the liberal lateral motion. As to these engines riding very badly, it has not developed that such is the case.

Replying to the question of piston speed, the example furnished by Mr. Nagle does not cover the case contemplated in our article, for the reason that we had in mind consolidation engines of 28 inch stroke, while he works on the hypothesis that such engines have 24 inch stroke, which, as a matter of fact, does not hold on the heavy locomotives of that type, and his figures work out very nicely to show that there is no difference in piston speeds. There is, however, quite a difference when a stroke of 28 inches is considered with a 50 inch wheel, a combination that has been running for several years. With the 50 inch wheels and 28 inch stroke, the piston speed at 30 miles per hour is 940 feet per minute, while with the 62 inch wheels and 30 inch stroke, the piston speed is 814 feet per minute; conclusions are easily drawn from the figures, but there is a matter of centrifugal force that enters here, and it is one so easily affected by wheel diameter that it assumes great importance.

The centrifugal force for the larger wheel at 30 miles an hour equals $\frac{W V^2}{g r} = 11.3$ pounds for each pound at a crank radius

of 15 inches, and a like force for the 50 inch wheel is 16.3 lbs. for each pound at the center of gravity of a 14 inch crank. This shows the connection between the large and small wheel for fast heavy freight service, but a ride on an engine with the 50 inch wheel at the speed noted is a more conclusive test, and never fails to convince the doubter that the larger wheel is preferable when conservation of permanent way and machinery is an object of importance.

As to the use of the consolidation engine in passenger service, objection is raised, presumably on account of the two wheel truck, which is thought by some to be an element of danger. We do not advocate the use of consolidation engines for hauling passenger trains (our statement on this point is clear), but if the truck is the objectionable feature, the point is not well taken for the reason that mogul engines have been, and are now, used satisfactorily in regular passenger service.

With reference to the increase of cylinders from 23 to 23¾ inches diameter, we certainly do not think that the tendency of the engine to slip will be any less. It is well understood that the tractive power exerted at the rail should not be less than the adhesion, even if the latter is obtained by extraneous aids, since it is perfectly plain that of two engines similar in all respects, that which is the most powerful is the one that has the greater earning capacity when loaded to the limit.

Adhesion is now increased by the use of perfected sanding devices that place sand on the rail in quantities to suit re-

quirements, enabling an engine to hold the rail under conditions that would be impossible without them. As intimated above, the tractive power is raised to a higher proportion of the adhesion in the later design of engines than ever before. Machines built on these lines must not be confounded with the over-cylindered engines of the past, with their very small boilers and inadequate heating surface. There is nothing in common between them. Those of the article in question, having a power closely approaching the adhesion, are well able to exert their maximum effort over long distances by reason of ample boiler capacity and heating surface, whereas the old engines that had a power rating on cylinder size alone soon became inert for want of steam capacity.

The proportion of adhesion to adhesive weight must necessarily depend on the condition of the rail and wheel, when these are considered alone, but experiments are not required now to demonstrate what that ratio is when the rail is fairly dry and sand is used. As a matter of fact, an adhesion equal to 25 per cent. of the adhesive weight is obtained under average conditions, and it is not uncommon to reach 30 per cent. with sand on a good rail. That is the reason why the ratio of tractive power to adhesion is increasing.—Editor.]

LIGHT AND HEAVY CARS.

Editor "American Engineer":

In your April, 1899, issue, you printed an article, "Light and Heavy Cars," that has greatly interested me.

Before going into the merits of the subject, the opinions of two highly successful railroad men must be considered. Mr. F. D. Adams, whom I have had occasion, during the last ten years, to consult frequently upon this very subject, says, "Light cars cannot be made to ride as well as heavier cars," and I regret exceedingly to say that Mr. Adams is greatly mistaken. The weight carried is not a factor in the riding of any moving vehicle, and so eminent an authority as Von Borries, Director General of the Prussian State Railroads, hopelessly errs in a paper he recently published on equalization and riding of locomotives, when he stated that the weight carried was the prime factor in the riding.

When you mention the riding of cars and locomotives you enter upon a unexplored field that the average railroad man has not the faintest conception of, and the leading railroad man is afraid to discuss because he does not know. The man who makes the springs is doing it under contract at a given price per pound, entirely regardless of the ability of the springs to absorb upward and downward thrusts.

Mr. E. E. Pratt, who is also a personal friend and with whom I have discussed this subject, also very frankly declares that he "does not think that a car must necessarily be heavy in order to ride smoothly." The operating expenses would show marked decrease if more of the men in charge of rolling stock would give careful study to dead weight, and also to devices that will cause this same rolling stock to ride with freedom from jolts and jars, and not act as sledge hammers to pound the permanent way to pieces.

In 1892, Mr. L. M. Butler, Superintendent of Motive Power of the New York, Providence & Boston R.R., equipped six four-wheel buggy vans that were 16 feet over the sills and weighed 11,000 lbs., with our combination half leaf and spiral suspension. The marvelous change from the jiggle motion with the old springs to a velvet smoothness with the leaf and spiral was a revelation to Mr. Butler and the trainmen using the vans. These six vans are still in service, and ride as free from teetering as the heaviest sleeper; further, it is impossible when riding in one of these vans to count the rail joints, frogs and switches, no matter what the speed.

This combination of leaf and spiral is in service on the palatial private trains of the President of France, His Imperial Majesty the Czar of Russia, the Oriental express sleepers and dining cars, the electric cars of Paris and Chalons-sur-Mer, France, Alexandria, Egypt, and hundreds of electric cars in the United States, and the Canadian Pacific Railway are placing it under their locomotives with gratifying results.

The Metropolitan Street Ry. of New York are operating a number of combination open and closed cars 28 feet over the end sills, with two trucks, having eight wheels, driven by two motors and weighing 14 tons and seating 45 passengers. Our car is 24 feet over the end sills, has four wheels, one motor, weighs 3½ tons and seats 40 passengers, and the floor of this car is only 26 inches from the ground. It rides free from jars and jolts, either loaded or empty, and the motorman can stop it easier and quicker with a full load than when empty, without fear of sliding his wheels, although the leverage is 12 to 1.

J. HECTOR GRAHAM.

Boston, April 16, 1899.

THE ATLANTIC CITY FLYER—PHILADELPHIA & READING RAILWAY.

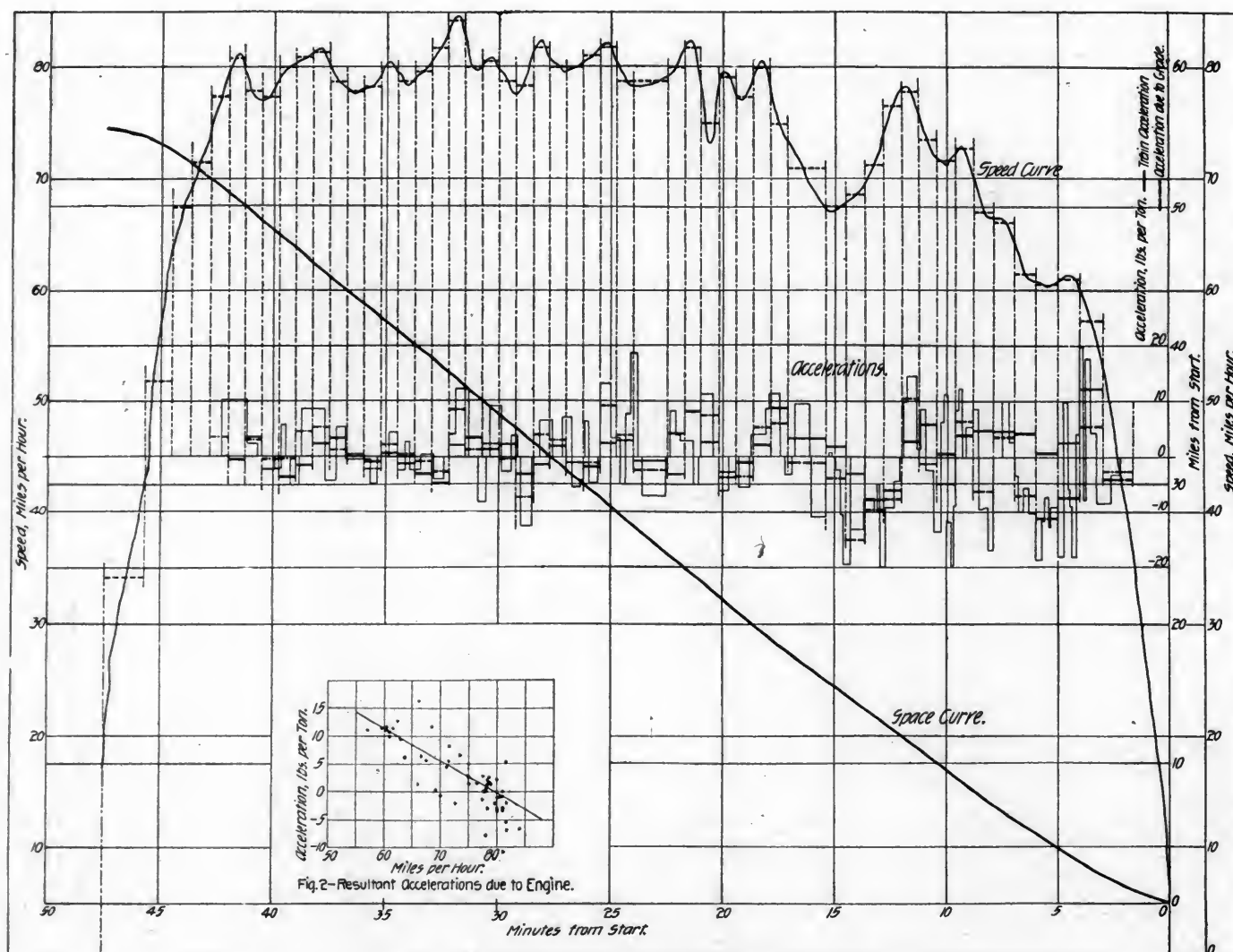
Speed Acceleration and Power.

BY H. H. VAUGHAN.

In view of the discussion recently developed by the experiments on the model of the Baldwin compound locomotive at Purdue University and the correspondence between those experiments and the practical working of such engines demonstrated by Mr. Vauclain, an analysis of the performance of one of the engines of the Atlantic type on the fifty-minute run from Camden to Atlantic City may be of interest, although not of any definite scientific value. When Mr. G. M. Basford, editor of the "American Engineer," last summer timed this train so successfully (see issue of October, 1898, page 341), the added times by each mile corresponding with the total time of the run within a second, the writer made the attempt, based on such an accurate record, to deduce some relation between the power of the locomotive and the speed of the train that should eliminate the effect of the grades. The method used is illustrated in the accompanying diagrams, Figs. 1 and 2.

In Fig. 1 the abscissae are minutes, and the ordinates are for the space, velocity and acceleration curves, miles, miles per hour and pounds per ton respectively. The space curve is obtained by plotting points, corresponding to the record, and the curve through such points represents the distance of the train

from the starting point at each minute of time. If this curve were to a sufficiently large scale its tangents would give the speed, but this method is inconvenient and not sufficiently accurate. The curve is however, useful, as by it the distance of the train from the starting point at any time, or, conversely, the time at which any point is passed, can be graphically obtained. A series of ordinates are therefore drawn, as shown in the upper part of the diagram, each of which corresponds to the time at which a mile post was passed. The horizontal lines between these ordinates represent the average speed for the mile which was passed in the time enclosed between them. Now, since this diagram is plotted with respect to time, the area enclosed between any two ordinates and the speed curve must equal the area enclosed between such ordinates and the horizontal line representing the mean speed for that time. This is shown in an approximate way by the curve which is roughly sketched in, which should show equal areas above and below the horizontal line. There is, however, no requirement as to regularity in the speed curve, apart from this question of areas, the only conditions are that it must be continuous and must not become vertical. A slight consideration will show that while the speed must change gradually, the rate of change of speed (shown by the slope of the speed line) may and probably does change practically instantaneously, or at any rate in a train length. For instance, suppose a train to be running at 70 miles per hour on the level, the engine exerting sufficient power to maintain that speed on arriving at a descending grade, within a train length acceleration will have taken place,



The Atlantic City Flyer—Philadelphia & Reading Railway.
Diagram of Speeds and Acceleration.—Figs. 1 and 2.

so that it is probable that the speed curve is in reality a series of curves and straight lines meeting at various angles. In fact, if both resistance and engine power are lineal functions of the speed, such must be the case.

On this account it appears impossible to definitely determine the speed line, and in consequence the acceleration or retardation in each mile. The only way is to obtain an approximation and for this purpose the speed on passing each mile post was taken as the mean of the speed in the preceeding and succeeding miles.

The acceleration thus assumed can be measured from the mean speeds in miles per hour, and by constructing a suitable scale it can be plotted as feet per second or as the force necessary to cause such acceleration in pounds per ton of train. This force is shown by the heavy horizontal lines above and below the base line in the center of the diagram, the measurements above the base line being accelerations and those below retardations. The effect of the grades is plotted to the same base line and scale by obtaining the time at which each change of grade occurred from the distance of that point from the start, and the time at which the train passed it as shown by the space curve. Each grade will exert an accelerating or retarding force on the train, dependent upon its rate, and these forces are shown by the distance of the light horizontal lines from the base line, the light vertical lines marking the time at which each change of grade occurs. The height of a rectangle enclosing an area between the base line and two adjacent mile lines that is equal to the algebraic sum of the rectangles formed by the lines representing the grade accelerations and the base line between the same mile lines then represents the mean accelerating force due to grade during the time in which each mile was travelled, and this is shown by the horizontal dotted lines. The difference between this and the actual acceleration, either positive or negative, is evidently that due to the engine.

These results are plotted in Fig. 2, in which the abscissae are speeds in miles per hour, the dots representing the engine accelerations in pounds per ton. There are evidently great variations, partly no doubt due to the method employed, but on the whole the line drawn is not a bad representation of the result and it is clearly apparent that the engine is capable of maintaining a speed with this train of nearly 80 miles per hour on the level, or 60 miles per hour on a grade of five-tenths per cent., a very fine performance.

It is to a certain extent unfortunate that on the day the train was timed the engine was not worked up to its capacity, as the run has been made in considerably less time, and the fact that 48 minutes had to be consumed in making the trip is no doubt to a certain extent the cause of the variation in power shown at the same speed, although the impossibility of obtaining the exact accelerations is responsible for the greater part of it.

The petty and foolish opposition that early railroad builders were made to encounter seems ridiculous nowadays, and one of the strangest efforts in that line perhaps was that made against the construction of the first road in Germany, between Furth and Nuremberg, in 1836, when the Bavarian Medical College came out in a pronouncement as follows: "Conveyance by means of a carriage propelled by steam ought to be prohibited in the interest of the public health, for the rapid motion cannot fail to create a disease of the brain among the passengers, which may be classed as a species of delirium furiosum. Even if travellers are prepared to run the risk, the onlookers ought by all means to be protected. The mere sight of a passing train suffices to create the same central disorder. This has been found out by experience and by actual observation. Wherefore, the authorities should insist on having a palisading of boards or of some similar material, at least 5 feet high, placed on each side of the permanent way."

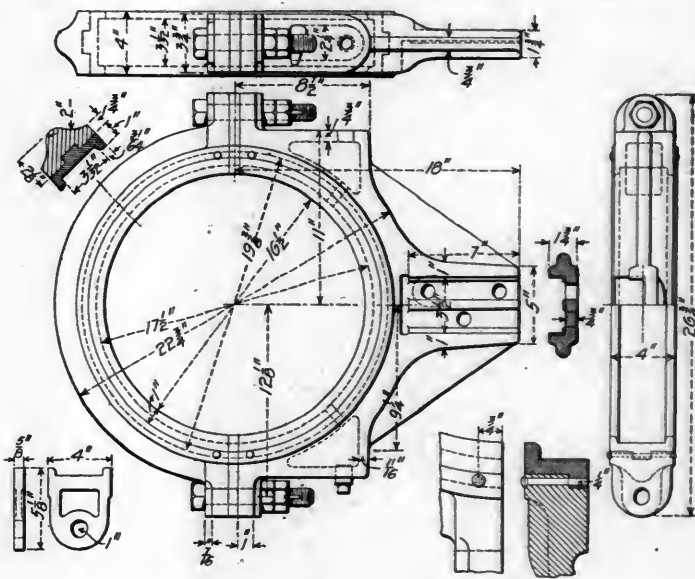
Great difficulty is reported by railroad men in getting rooms for the convention at Old Point Comfort.

BRASS LINED ECCENTRIC STRAP.

Chicago & Northwestern and Chicago, St. Paul, Minneapolis & Omaha Railways.

Many different methods have been tried in order to prevent trouble with heated eccentrics. The eccentric straps have been bored out and the bearing surface lined with babbitt metal, and, in some cases, the entire straps have been made of brass. In the accompanying engraving a brass lined eccentric strap is shown. It has all of the advantages of the all brass strap as to the quality of the bearing surface and is less expensive. With the brass liner carefully secured against revolving, this plan appears to be as good in every way as the more expensive one.

The drawing shows the form of the eccentric strap as made in cast steel. The liner is cast in a single piece and is cut to allow space for two $\frac{3}{8}$ -inch filing pieces, which are placed between the lugs. These serve to hold the liner from turning



Brass-Lined Eccentric Strap.

and also provide for taking up wear of the liner. The section of the liner and strap show the flange or rib on the outside of the liner, through which pins are passed near the lugs for the purpose of holding the liner in place when the strap is removed from the engine.

The experience of the Chicago & Northwestern shows that this arrangement reduces friction and the breaking and heating of eccentric straps is prevented. It is used on all new passenger locomotives for the Chicago and Northwestern. The credit for the design belongs to Mr. J. J. Ellis, Superintendent of Motive Power of the Chicago, St. Paul & Minneapolis & Omaha.

Mr. Ellis informs us that the first set of these straps were applied to a 19 by 24-inch ten-wheel locomotive running in fast passenger service and that they ran three years before they needed to be closed. The amount taken out at that time being but 1-16-inch. The straps are of cast steel and the liners of Ajax metal. Mr. Ellis says: "Most of our passenger engines are equipped with these cast steel eccentric straps and Ajax metal liners and are giving excellent service."

Electric motor carriages have received a severe blow in London through the removal of the electric cabs from service. According to published accounts, this was due to the expense of maintaining the storage batteries that were used there. The trouble arose from excessive expense of maintenance and a misunderstanding of the terms of the guarantee which resulted in this expense falling upon the cab company.

BURNISHED FINISH FOR JOURNALS AND PLAIN SURFACES.

While the use of rollers for producing burnished surfaces of journals and piston rods is now generally considered a great improvement upon other finish, it has met opposition from individuals, one of whom said only last year that he preferred to finish such surfaces with files and emery, because of the alleged poor condition of the surface given by the rollers. It may be said that where the roller has failed, the blame should not be placed on the method, but on its application.

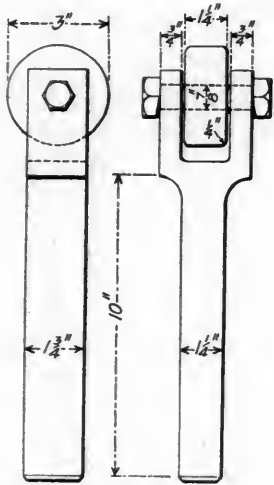


Fig. 1.

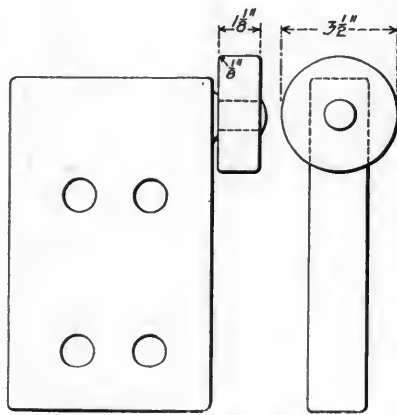


Fig. 2.

The rolled finish offers two advantages: First, in producing a smooth surface, and, second, in making the surface denser, and therefore harder. In producing these results all minute seams are closed and the surface is placed in a "broken in" condition at the start, which accounts for the remarkable absence of trouble from hot boxes when journals are finished in this way. It is necessary that the roller should have a working face free from scratches or grooves, or, in other words, it must be made as smooth as possible, and it must also be hardened before the final polish. Such a tool will produce a surface fully equal to that of cold rolled shafting, which on account of being smooth, dense and true, was thought a few years ago to be well adapted for piston rods, and was tried for that purpose; but it was found to be a poor substitute for the good iron then in use, for the reason that after the rolled surface had been worn through and a turning was necessary, the seamy surface exposed showed the cold rolled iron to be unfit for such use after the first wear, but it demonstrated that a cold rolled surface was satisfactory for piston rods.

No way has yet been devised by which steel can be finished sufficiently smooth direct from the tool to make an ideal bearing surface, and the barbaric file and emery are called into requisition to supply what the tool has failed to furnish. The tool leaves the work comparatively true, but not smooth enough, and the file reverses the conditions by leaving it smooth enough and comparatively untrue. The province of the roller is to retain the truth of the turned surface and at the same time put it in the best possible condition to resist abrasion; this it does with varying degrees of excellence, according to the condition of the tool and the way it is used. In any event, the work when well done is better and cheaper than by any other process, a fact that is attested by our best machinery department managers, although there is some difference of opinion in the matter of width of roller-face and amount of curvative of the edge, as will be seen by the examples we illustrate. They all, however, produce a mirror-like surface.

Fig. 1 shows the practice of the New York, New Haven & Hartford. The corners of the wheel are seen to be rounded off to a radius of 1/4-inch, corresponding to the fillets on the journal. This tool had a record of several thousand axles when

we saw it and was still in first-class condition. A bush will be noticed in the roller, the purpose of which is to permit of taking up lost motion due to the thrust of the roller against the journal.

The Chesapeake & Ohio people use the roller on all axles, crank pins and piston rods. The roller for driving axle journals is shown in Fig. 2, the holder being a flat piece which is held by the tool bolts, and is reversible to adapt it for use in either direction, owing to the peculiarity of the service required of it. The roller for the other work named is quite similar to Fig. 1. This road gives the roller a very extended use, and file finishing is not permitted.

The practice of the Canadian Pacific, as shown in Fig. 3, furnishes an idea in original constructive detail in the bearing of the hardened steel roller in the tool steel shank. The roller is journaled and rests in the forked bearings. The pressure of the roller against the work holds it in place, and the incline of the bearings prevents displacement of the roller when not in use. Mr. R. Atkinson, Mechanical Superintendent of the Canadian Pacific, writes of his roller, as follows:

"I send you herewith a sketch of the roller which we use on journals and piston rods. You will notice that the roller has a flat face about 5/8-inch wide, which is amply sufficient to prevent corrugation or cording of the surface if it is carefully set, and I think it is better than to have the roller wider or larger in diameter, as has been suggested, and I understand is being used in some places. A roller of double the width requires twice the pressure against the lathe centers to produce the same surface effect and is therefore liable to spring the work or throw it out of the lathe. One-quarter-inch feed is easily covered and is ample to do fast work. It takes 45 minutes to burnish the largest piston rod we have with an extension tail rod for compound engines, namely, 6 feet 11 5/8 inches long over all, 3 11-16 inches diameter of rod, and 2 1/2 inches diam-

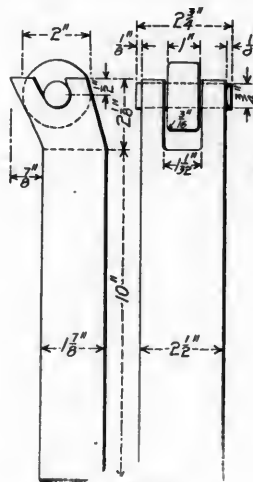


Fig. 3.

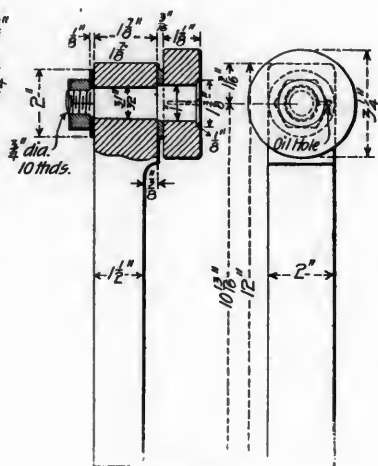


Fig. 4.

eter for the extension tail rod. A similar piston rod without a tail rod can be burnished in thirty minutes, main crank pins in fifteen minutes, leading or trailing crank pins in seven or eight minutes, and I am sure no exception can be taken to the finish produced, as I have not yet seen any better anywhere. The speed for piston rods is about 120 feet per minute, and for crank pins and axle journals 90 feet."

The roller shown in Fig. 4 has some novel and original points, giving evidence of adaptability of the tool to a wider range of work than any one roller so far devised. The roller it will be seen is placed at one side of the shank or holder and can therefore be used with equal facility on straight work without shoulders, and driving axles or engine truck axles where the roller must be moved up to the wheel hub; this it is enabled to do, because it is reversible and may be turned to work to a shoulder in either direction. Its construction is well explained by the illustration. Mr. J. H. McConnell, Superin-

tendent of Motive Power of the Union Pacific, through whose courtesy we show this roller, writes of it as follows:

"We make use of this tool for the following purposes: Burnishing piston rods, valve stems, crank pins, driving axles, engine truck and tender axles and passenger and freight car axles. In addition, we use it to burnish the wedge faces of steel

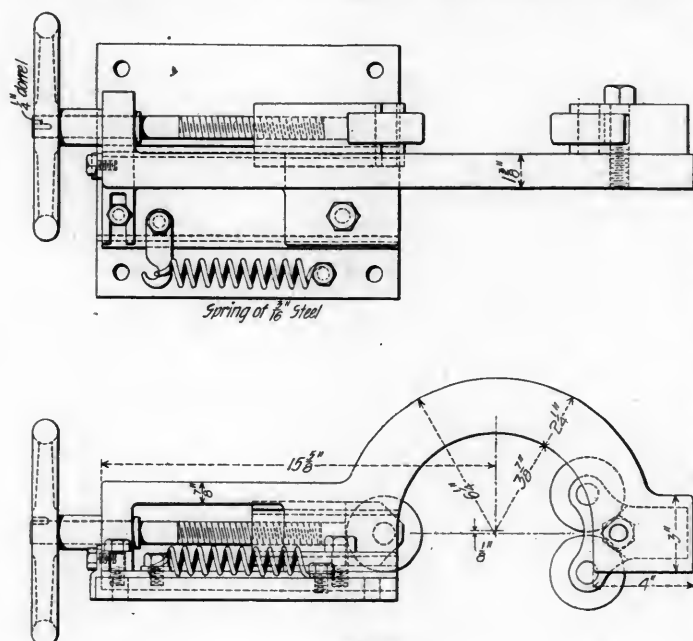


Fig. 5.

and cast iron driving boxes, also the driving box wedges and shoes. It is of great advantage to run this tool over the wedge faces of the cast steel driving boxes and shoes, as it condenses the surface of the metal and gives a smooth surface equal to that obtained by long wear in service. We find by this method that steel driving boxes run without cutting. An examination of a set after one year of service showed a surface like glass without a scratch. I believe it reduces the number of hot driv-

three rollers three inches in diameter by $1\frac{1}{4}$ surface, journaled in a frame which is secured to the lathe bed permanently, as seen by the bolt holes in the plan. The frame is curved so as to pass over and clear the work operated on, and it has two supporting wheels in the rear while the single wheel at the front is adjustable to the work by means of the hand wheel and screw as shown. The device is certainly a novel one, in that it furnishes support for the work operated on, and effectually prevents spring from the strain of the adjustable roller and it relieves the lathe centers from additional stress.

An arrangement devised by Mr. W. H. Owens, Master Mechanic of the Southern Railway, is shown in Fig. 6. This employs two rollers as a support for the piece, while the tool rest also carries a third roller, the device being arranged in this way with special reference to burnishing piston rods and valve stems which are so light as to bend under the pressure of a single roller. For rods of larger diameter, and for axles and crank pins a single roller, three inches in diameter, with a face two inches wide, is used.

The statement made by Mr. Atkinson relative to the increased pressure required with the wide faced roller is a timely one and in strict accord with the facts for single rollers. It should have the effect of reducing the width of the roller to the narrowest possible dimension consistent with smooth work. This, of course, will depend entirely on the rate of feed used. The hint is a valuable one, inasmuch as it will relieve the lathe and work of unnecessary stresses when the roller is properly designed. Mr. McConnell has shown the increased possibilities for the roller in his adaptation of it to the burnishing of plane surfaces. This is a unique and decidedly original use of the tool, and one as productive of good results as in any work it may be devoted to, not excepting that for which it was first designed. Its action is exactly similar wherever used, that is, making the surface denser and smoother; and there is no place on a locomotive where that condition is more desirable than on the faces of wedges and shoes and the corresponding surfaces on driving boxes. It appears to be specially adaptable to cast steel surfaces.

The rollers devised by Mr. Barr and Mr. Owens have been designed to overcome the springing of work referred to by Mr. At-

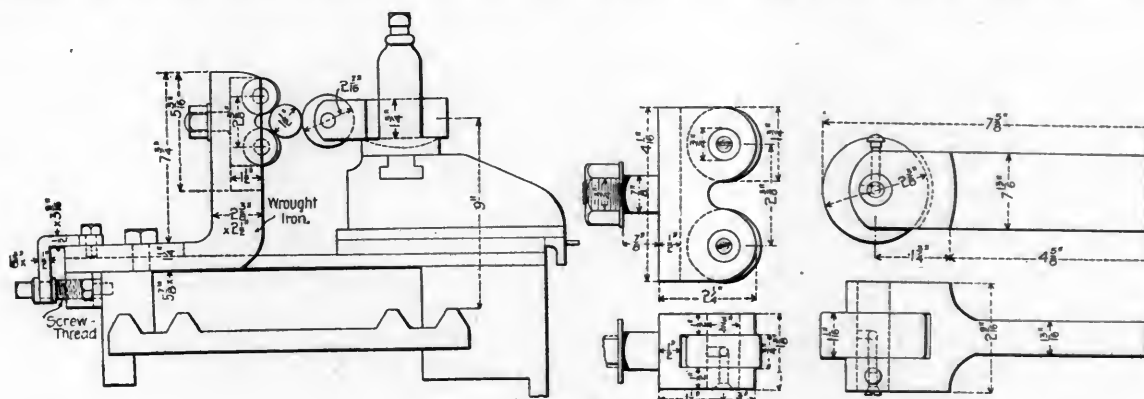


Fig. 6.

ing, tender and passenger car boxes. After the practice is once adopted, I do not believe any one would be willing to abandon it. The cost is less than by the old way of using a file and emery, as a coarser feed may be used when taking the water cut, because the roller does the rest."

Mr. J. N. Barr, Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Railway, says:

"We consider that the liability of journals to run hot is materially reduced by the use of this device. We have, since the rollers were last repaired and hardened, rolled 4,200 axles and there are no signs of the rollers needing repairs at present."

The tool referred to by Mr. Barr is shown in Fig. 5. It is more elaborately gotten up than any of the others and is designed on entirely different lines. The side elevation shows

kinson and are admirably adapted to that end, for work of a diameter likely to be distorted by pressure of the burnishing wheel. In this presentation of the evolution of the roller it is seen that there is more to it than is commonly believed, and also that its field of usefulness is being extended in a direction little expected by the man who first thought of it only as an improvement over the file for finishing journals. Our best information as to the origin of the roller for axle work (and this is believed to be its first use on the lathe in a railroad shop), gives credit to Mr. L. Barrett, Master Mechanic of the Missouri Pacific at St. Louis, Mo., as the inventor of the device, who conceived the idea of burnishing a journal, and followed up the idea to a successful conclusion. This occurred in 1891 or 1892.

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The best iron, without regard to the price, is recommended by Mr. Francis Cole elsewhere in this issue, for making locomotive spring hangers and equalizers. His reason is made plain when he shows that iron having a tensile strength of about 48,000 pounds per square inch and an elongation of 25 per cent. in 8 inches, can not be safely used in these positions with fiber stresses greater than about 3,500 or 4,500 pounds per square inch for spring hangers, about 4,000 or 4,500 pounds for equalizer fulcrums and from 10,000 to 12,000 pounds for equalizers. These are very low limits, but they have been determined by experience, and they furnish a strong argument for the use of the best iron that money can buy. There is very little of this iron needed about a locomotive and the additional cost will hardly be noticed, whereas the return in the cost of repairs and the ability of the engines to keep the road may be expected to be very great.

Freedom among manufacturers in imparting information with regard to methods of manufacturing has had much to do with the remarkable progress of the United States during recent years. The technical associations have accelerated progress in this way and free criticism concerning methods has brought many improvements. Progress depends so much upon this free information idea that it may be said that the secret process plan is confined to small establishments and it is very seldom heard of in connection with the stable articles of manufacture. It is those lines in which the doors are wide open in which the world startling developments have been made. The man who leads is always ahead and is spurred on by being in the lead while he who follows without originating is always behind. In the open door plan, traditions have no place and improvement is the rule. Those who are unwilling to share their information are usually unwilling to learn and are followers being even behind those who follow intelligently. We have in mind business organizations having bright men at the heads of departments, who are not only discouraged from appearing in technical societies but are positively instructed not to take part in their discussions because nothing is to be gained by "giving away" information in this way. Is this a business-like way of looking at this important matter?

The size of driving axle journals of locomotives, as seen in a number of recent designs, seems to be one of the details that is considered comparatively unimportant, because of the variety of practice that is found. Our attention is directed to this matter by the practice of one of the locomotive building firms, which is illustrated by two locomotives of very different types and weights, both of the designs being shown by engravings in this issue. One of these locomotives is of the consolidation type, weighing 173,000 pounds on the driving wheels, and the other is a mogul weighing but 123,700 pounds on its drivers. These two designs have exactly the same sized driving journals, namely 9 by 12 inches. As we understand it, this means that these builders believe in using the largest journals that they are able to provide for in the structure of the engines, for these are but two examples of practice that they have followed for some time. It may be said that the load carried by a driving axle does not vary very much in powerful engines of whatever type, because of the desire to load the wheels as heavily as track conditions permit. In the cases cited the load on each journal of the mogul is only 1,000 pounds less than that on each journal of the very heavy consolidation engine, but as the lighter engine will probably run in very much faster service than the other, the maximum fiber stresses may not be very different. It appears to be a good plan, especially as the fiber stresses are not to be measured, that the journals should be made as large as structural conditions will permit. Surface velocity will be troublesome after a certain diameter is reached, and the weight will prevent the dimensions from going to extremes, probably the direction that future axle design will take will be in the use of stronger material.

Valve gears are usually designed with considerable care and they are intended to distribute steam to the cylinders favorably, especially when the valves are balanced, but it is well known that the intended distribution is not always attained. Interesting examples of the variable amount of work obtained from the same engine without altering the cut-off speed or steam pressure described by Prof. Smart in an article to appear next month. This may be considered as an additional argument in favor of piston valves. Prof. Smart also directs attention to the bad effect of even slightly increasing the clearance in locomotive cylinders. This must be kept in mind when designing piston valves. We know of simple locomotives in which a change from flat to piston valves has brought about an improvement in economy equal to that generally expected from compounding. This leads to the conclusion that compounds with piston valves ought to be very economical and this view is supported by service records.

AMOUNT AND DISTRIBUTION OF WORK IN BUILDING A LOCOMOTIVE.

Planning and estimating the requirements and cost of new shops is a difficult problem that occasionally confronts motive power men. Except notes that individuals have collected in the course of their experience, there are no data from which to estimate the number of tools of each kind that will be required to build or repair a given number of locomotives per year, and yet this is the first information that is required. We have been repeatedly asked for information of this kind and we appreciate the need for a complete analysis of the detail work on a locomotive. It would be valuable as a starting point in many important matters of shop management in which knowledge of costs is required and accurate knowledge of costs is the foundation of businesslike management.

Details taken in building locomotives are available from the painstaking and laborious investigations of Mr. T. R. Browne, who has analyzed the construction of a modern consolidation locomotive, and the results were printed in his article in our January (1899) issue, page 23, under the caption, "General Summary of Tools and Their Arrangement." The information contained in this article is an excellent beginning for the general analysis that ought to be made, and we desire to direct attention to it again, because such figures have never before been published.

Calculations were made to embrace the important operations on a locomotive of the consolidation type, the purpose being to avoid minor details, such as tank work, foundry work, and wood work, a consideration of which would surround the subject with unnecessary complications. The results are stated concisely in the following table under the general divisions and subdivisions:

TOTAL AMOUNT OF WORK IN MACHINE SHOP.							
Plan- ing. Square inches.	Turn- ing. Square inches.	Boring. Square inches.	Milling. Square inches.	Slotting. Square inches.	Cold- sawing. Square inches.	Drill- ing. Linear inches.	Tap- ping. Linear inches.
77,089	83,419	9,915	13,995	20,116	595	6,852	612
TOTAL AMOUNT OF WORK IN BOLT DEPARTMENT.							
Blacksmith shop:—							
Turning.		Threading bolts and studs.			Threading nuts.		
Linear inches.		Linear inches.			Linear inches.		
3,363½		11,421½			2,833½		
TOTAL AMOUNT OF FORGING IN BLACKSMITH SHOP.							
Total amount of forging in blacksmith shop, including forgings of bolt department.....							61,819 lbs.
TOTAL AMOUNT OF WORK IN BOILER SHOP.							
Planing edges of plates.		Shearing.		Punching.		Tapping.	
Square inches.		Square inches.		Holes.		Linear inches.	
2,253		2,653		10,915		733	

The operations in the several shops are given in terms of square and lineal inches of cutting, which is a novel and rational way to put the results, since they afford a means of arriving at the cost of such work at once. Brass work is not included in the table, for the reason that the amount of such work for one engine bears a small ratio to the iron work, and the means now used in finishing brass are of such an improved character that it was believed to be unnecessary.

It is shown that 46.3 per cent. of all planing is done on frames, cylinders, footplates, guide yokes, truck plates, frame braces, steam chests, bumper castings and pedestal braces. In all turning operations 64.2 per cent. is covered by wheel centers, tires, axles, lift shafts, rockers, cylinder heads, pistons and rings, boiler rings, front ends and extension rings, steam chests, eccentrics and straps. Of slotting, 70 per cent. is required on frames and braces, crossheads, foot plates, bumper castings, guide yokes and driving boxes. Of the milling, 87 per cent. is required by guide yokes, crossheads, rods and braces, mud rings, guides, main axles, links, link hangers and guide yoke knees; 89 per cent. of the boring is done on cylinders, crossheads, rocker boxes, lift shaft bearings, lift shafts and rockers; 68.7 per cent. of the drilling is required on rods, crossheads, holes for pedestal bolts and cylinders. Of the work of tapping holes, 6 per cent. is called for on cylinders, pistons and other large details, and these are tapped in the machine where they are drilled.

The gaps in these figures are filled by smaller parts by a system of grouping at special tools. Seventy per cent. of bolt and stud turning in the bolt department of the blacksmith department shop comprises bolts and studs from 5/16 to 1 inch, and the remainder from 1 inch and above. Of the thread work, 74 per cent. includes bolts and studs from 5/16 to 1 inch, and the balance from 1 inch up. In the tapping of nuts, 39 per cent. are comprised in nuts from 5/16 to 1 inch, and the remainder from 1 inch up.

A continuation of the information in percentages shows the total of forging to come within the following range: 58.9 per cent. takes in frames, braces, guide yokes, rods, truck plates, pistons, and that variety of heavy work done on hammers of from 6,000 to 8,000 pounds capacity; 20 per cent. is in mud rings, front end extension rings, spring rigging, link and valve motion, crossheads, link shafts, rockers, and also those forgings reaching the capacity of a 3,000-pound hammer. Bolts and work done in the bolt department absorb 6 per cent., and all of the smaller classes of forgings for which it is not desirable to make by special tools and which are usually done on the anvil, constitute the balance of the smith-shop work.

Although the steam hammer is referred to as a prominent adjunct in a larger part of the blacksmith shop work, equal prominence is given to production of forgings by means of dies, the analysis being specially valuable in directing attention to possibilities for reducing the machine work and performing the work in such ways as will permit of saving the time of the machines. One of the advantages of die work in forging is to be found in the small amount of stock necessary to be left for removal in finishing, in many cases grinding sufficing for the purpose, which is one of the results of dies properly made and used. Another argument in favor of the dies is the fact that intricate shapes can be more expeditiously turned out by them than is possible by any other method of forging. The dies are used with pressure and not impact, for it is well understood that a blow will not cause a flow of metal and will not reach the interior of metal so readily and satisfactorily as pressure. A forging machine will reduce the cost of blacksmithing, and will also materially reduce the time consumed in removing stock in the machine shop, a saving of labor in both operations. The steam hammer, owing to extravagant consumption of steam, it is thought, may be replaced by the forging machine at a less cost for steam to get the pressure for the hydraulic machine, for equal capacity of tools.

An important result of this examination was to show that about one-half of the time of the shop tools is taken up in the fixing of work and in the recovery of the tools for the next cut. About one-third of the time of reciprocating tools while running is taken up in the recovery of the tool for the next operation. One-half of the time of a steam hammer is spent with the hammer head in the air, and the same may be said of ordinary punches. About one-half of a man's time is spent

in waiting for the machine to do its work, and if the time of both men and machines could be economized, the costs might be reduced considerably. There is an opportunity to make great improvements in this direction by the use of fixtures in the machines whereby the work may be dropped in place and fastened without the necessity for special care in placing it. By the use of such devices an ordinary man may be used to take the place of the expert mechanic required by the usual methods, and the work may be, at least, as well done. This, by the way, is a strong argument for the adoption of uniform sizes of parts.

That portion of the article under discussion which refers to the "personal equation" of the individual operator and its application to the percentages given is one of greatest importance in its bearing on the results, for the reason that the wage question and ability of the worker will enter as factors to vitiate or sustain the figures given in the tables indicating the amount of work required for one engine. The recommendations and suggestions made are of the greatest importance to the progressive head of the railroad shop, and we cannot do better than to recommend all who are interested in cheapening the cost of shop production to familiarize themselves with the whole of the article. It cannot but be of interest in any case, and will be found invaluable in many.

A strong argument in favor of cleaning locomotives at frequent intervals, offered in a recent discussion, was that of safety. By the examination incident to the wiping of engines a great many defects and incipient break downs are discovered before they become serious enough to cause failures on the road, and many that are discovered in this way would escape an inspector.

The stereopticon is used very successfully by Mr. W. J. Murphy, Superintendent of the Cincinnati Southern, in the instruction and examination of employees of that road. It has many advantages over other methods, because, by the use of slides, the candidate may, in effect, be taken to any part of the road and brought into contact with the conditions as if he were actually on the ground. This is particularly valuable in the case of questions in regard to signaling, and the plan will appeal to those who have tried to explain the use of signals by diagrams, or, in fact, by any method other than by the signals themselves. Mr. Murphy, however, is able to place various examples of signaling before the men in a way that is both quicker and better than the use of the objects themselves. The plan is a good one that should bring out a great many imitators.

The deepest sounding on record, says the "Army and Navy Journal," has been obtained by the officers of the surveying ship *Penguin* (Captain Field), which recently returned to Sydney from her work in the vicinity of the Tonga Islands. Between Tonga and Auckland a sounding was obtained at the depth of 4,762 fathoms, the patent sounding machine supplied to all ships of war being used for the purpose. The temperature at this depth was 35.5 degrees, as compared with 82 degrees at the surface of the water. A depth of 4,655 fathoms had been found previously off the coast of Japan by Commander Blake, U. S. N.; 4,561 fathoms off Porto Rico, by Lieut. Comdr. Brownson, U. S. N. This depth of 4,655 has been questioned because the wire broke and no specimens were brought up, but there was a record on deck the moment the wire ceased running out. The previous day the wire broke at 4,411 fathoms. Specimens were obtained two days before at depths of 4,360 and 4,356 fathoms. These soundings were made by the U. S. S. *Tuscarora* in June, 1873, between Yokohama, Japan, and Tanaga Islands, Aleutian Group. There was also a sounding of 4,643 fathoms when the wire broke before reaching bottom.

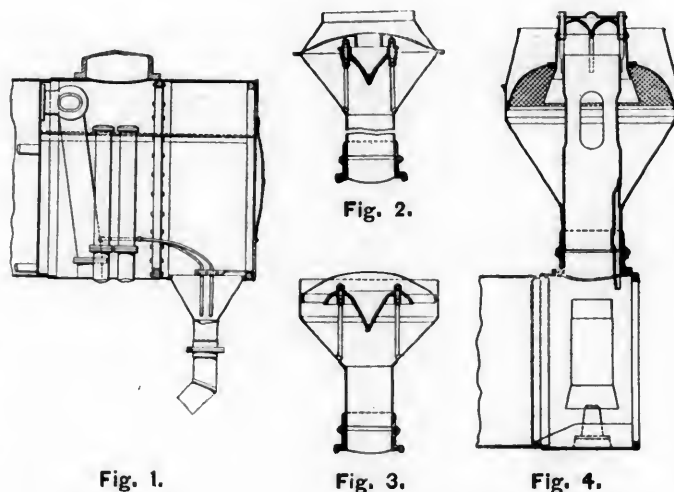
A CHAPTER IN LOCOMOTIVE STACKS.

Union Pacific Ry.

It is well known that the Union Pacific practice in the matter of front end arrangements includes the diamond stack. This form is not now in general use on other roads, but it was decided upon by Mr. J. H. McConnell, Superintendent of Motive Power, as being the best arrangement for securing free-steaming qualities and preventing the serious losses from fires which were set in large numbers by the peculiar action of lignite fuel in combination with open stacks. Mr. McConnell is always ready to defend his present practice with the strong argument that good results are given by it, particularly in regard to free steaming and elimination of spark throwing.

He has had the kindness to prepare for us a series of drawings showing the variety of designs of stacks covering the experience of that road from 1864 to the present time, and, contrary to the opinion of many, the road has certainly given a great deal of attention to the straight stack, as this record shows, and before deciding upon the present standard a number of designs of straight stacks were used.

The Congdon smoke-box plan, patented by Mr. J. H. Congdon



in 1864, and applied by him when Superintendent of Motive Power of this road, in 1867, is shown in Fig. 1. This arrangement had a horizontal netting near the top of the high nozzles which were double, and one in front of the other. No dimensions are given in this drawing, but it is evident that the extension front was a long one. This was used on a number of engines for several years, when it gave place, in 1870, to the Jarett diamond stack, Fig. 2. This was followed by the Fountain stack, also of the diamond pattern, in 1875, Fig. 3. In 1878 another form of the Congdon stack, Fig. 4, was used, and a return was made in 1885 to the straight stack shown in Fig. 5.

In 1885 eight different arrangements of this straight stack were tried, the general plan being as shown in Figs. 5 and 6, the difference being in the location of the deflection plates, of which some used one and others two and even three. In 1888 the "Barnes" extension front end, Fig. 7, was employed. The plate A shows the fender as first arranged, and B shows its position afterward. An arrangement of additional nettings, as in Fig. 8, was applied in 1889, and later in the same year a modification of the "Barnes" plan was used, as indicated in Fig. 9. Figs. 10 and 11 were used simultaneously, and in 1890, which we believe was the date of Mr. McConnell's appointment, a return to the diamond stack, as in Figs. 12 and 13, was made. It will be noticed that the form shown in Fig. 13 has a short extension. The straight stack, Fig. 14, was used to some ex-

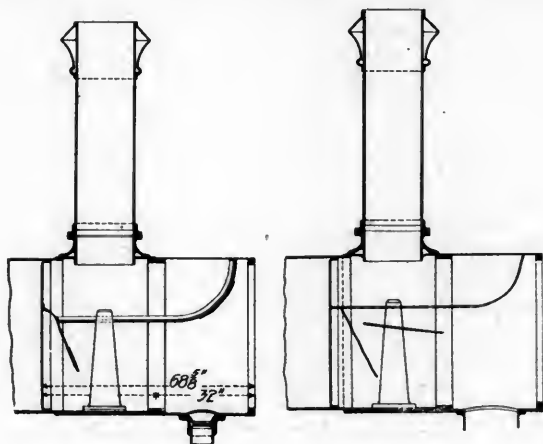


Fig. 5.

Fig. 6.

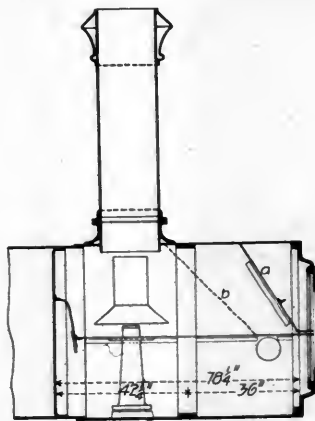


Fig. 7.

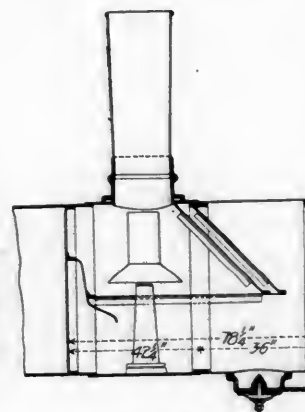


Fig. 8.

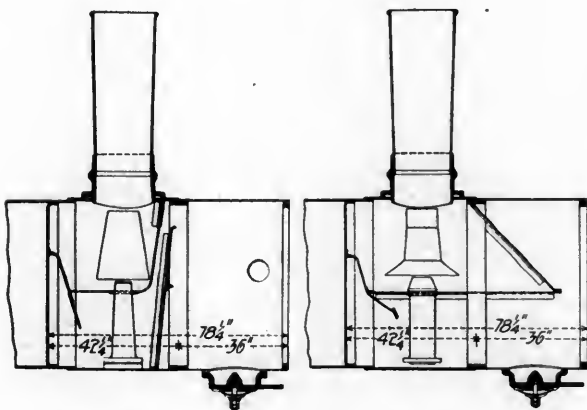


Fig. 9.

Fig. 10.

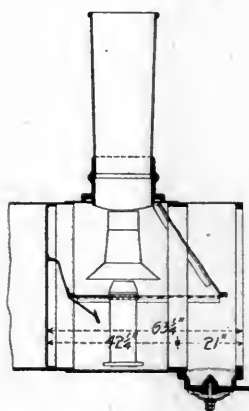


Fig. 11.

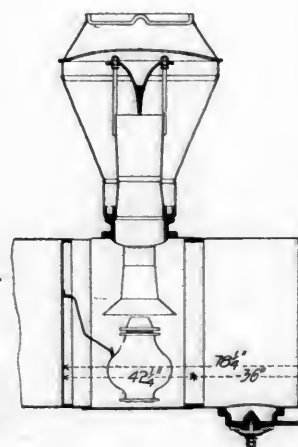


Fig. 12.

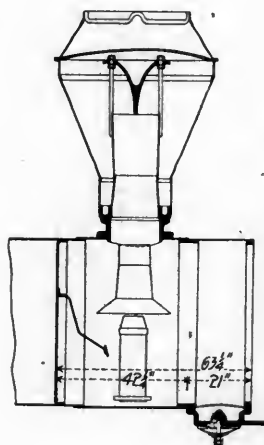


Fig. 13.

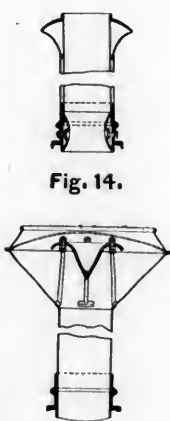


Fig. 14.



Fig. 15.

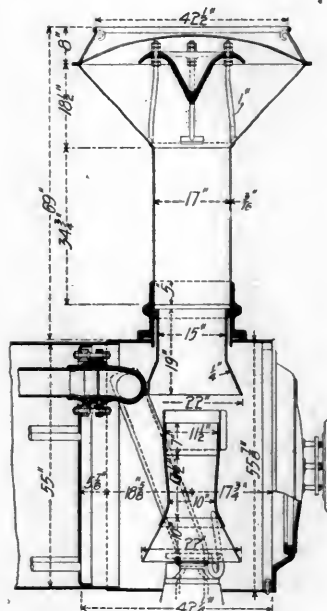


Fig. 16.

September, 1898.

tent at this time, but Fig. 15 indicated the return to the diamond pattern, now the standard form of the road. The present standard, including the low nozzles, petticoat pipe, stack extension and very short smoke-box, is presented in Fig. 16.

In order to understand Mr. McConnell's position in the matter of stacks it is necessary to consider the character of the coal used on that road. A great deal of it is lignite, which burns very much like wood, and the spark throwing is a serious matter. The appearance of the usual straight stack while burning this coal resembles that of the stream of sparks from the tail of a rocket, which renders the prospects of extensive

prairie fires exceedingly promising. There is no reason to object to a return to former practice when the results justify it, and where diamond stacks work better than open ones, they should be used.

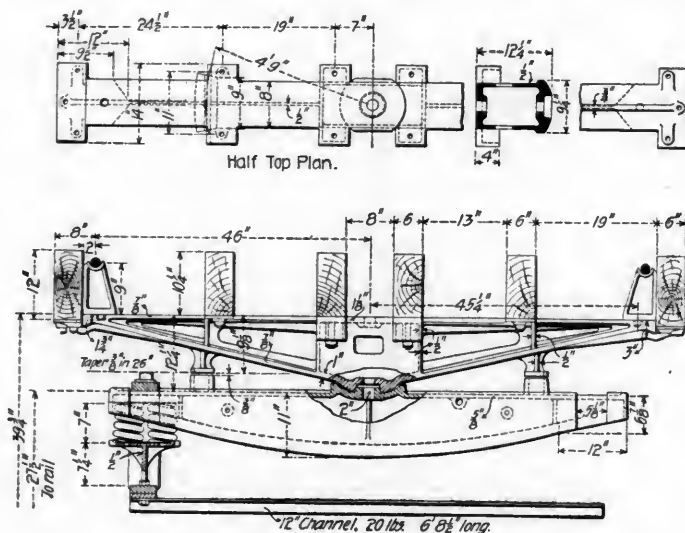
TRUCKS FOR 80,000-POUND CARS.

Cast Steel Truck and Body Bolsters.

Delaware & Hudson Canal Company.

Through the courtesy of Mr. R. C. Blackall, Superintendent of Machinery of the Delaware & Hudson Canal Company, we are enabled to illustrate the design of trucks with cast steel truck and body bolsters, used under a number of gondola cars of 80,000 pounds capacity.

This truck is of the arch bar type, with the column guides and spring seats combined in steel castings. The spring plank is in the form of a 12 by 20-inch channel. The whole arrangement was designed with a view of reducing the number of separate pieces to the minimum and at the same time to produce a structure that would be sufficiently strong to permit of carrying the load entirely upon the center plates. The bolsters and other steel castings were designed and furnished by the American Steel Foundry Company of Granite City, Illinois, and these parts are guaranteed to outlive the cars without excepting wrecks. They are giving satisfaction to the officers of



Cast Steel Truck and Body Bolsters.

Delaware & Hudson Canal Company.

the road, which is manifested by orders for large quantities. In describing similar trucks by these manufacturers for the Seaboard Air Line in our issue of September, 1898, we quoted from a letter received from Mr. W. T. Reed, Superintendent of Motive Power of that road, as follows:

"The idea of applying such bolsters to freight cars is to dispense with the many parts which require additional labor on trucks used previously of the same pattern as far as the arch bars were concerned, with flitch plate bolsters. . . . The time has now arrived when mechanics can readily see the advantages to be gained in the minimum number of pieces in any part of a truck or other machinery, and it is to this end that I find it most advantageous. What we need is a truck that will stand all abuses possible after derailments, so that the trucks may be replaced on the tracks and continue their journey, while others must be taken apart."

The reason why English locomotive builders have not captured and held the locomotive business for South America, Africa and other fields, against American competition, is stated by "The Engineer" to be that the builders "insisted on supplying, so to speak, chronometers, when a 'Waterbury' was the thing wanted." In other words the English locomotive is too good a machine to be run on ordinary railroads.

IMPROVEMENTS IN BOILER MATERIAL.

Improvements in steam engine practice in the direction of higher steam pressures have caused equally marked advances in boiler construction, and particularly in the quality of the materials, without which higher pressures would be dangerous and entirely impracticable. About 20 years ago pressures rose from 50 to 100 pounds, and since that time the water-tube boiler has brought about the use of 250 pounds, reduced to 200 pounds at the engines. This development and the improvements in materials which rendered it possible, are discussed in a valuable paper printed in the "Journal of the American Society of Naval Engineers."

The general reliability and uniformity of mild steel has been an important factor in this progress. This is due chiefly to the fact that purchasers of boiler material have insisted that it must meet severe requirements, and the thorough inspection and tests of the Bureau of Steam Engineering of the Navy Department has exerted powerful influences in this direction. Nickel steel commands a great deal of attention for braces and rivets may be made with a tensile strength of 75,000 pounds and an elastic limit of 40,000 pounds. This means that smaller rivets may be used and the strength of joints increased by reason of cutting away less material for the rivet holes. The strength, toughness and uniformity renders nickel steel particularly desirable for braces and rods. An example illustrated in the paper is spoken of as being as tough as steel can be made. It is very uniform and exceedingly reliable. When subjected to a drop test it tears a grain at a time, holding together during many blows after fracture. In several cases where bars 4 inches in diameter, of this composition (carbon 0.23, sulphur 0.017, manganese 0.61, nickel 3.22 and phosphorus 0.021, with average tensile strength over 80,000 pounds, and elastic limit over 55,000 pounds, and an elongation of more than 23 per cent. in 8 inches) have been tested under a 1,640-pound weight, dropping 44 feet, the bars being supported at the ends and turned over after every blow, it required 40 blows to cause the first fracture and 40 more to complete the break.

Comparisons between the requirements of the material by the Bureau of Steam Engineering in the boilers of the "Maine," built in 1888, and those for torpedo boats, monitors and battleships commenced in 1898, give an excellent idea of the progress that has been made. Ten years ago shell plates were required to have tensile strength between 58,000 and 67,000 pounds, an elastic limit of 32,000 pounds and elongation of 22 per cent. To-day the requirements are: Tensile strength, 74,000 to 82,000 pounds; elastic limit, 40,000 pounds; and elongation, 21 per cent. In 1888 rivets and stays were required to have a tensile strength of 50,000 to 58,000 pounds, and now they must have 75,000 to 85,000, and other properties in proportion.

The increased steam pressures require corresponding increase in the care and watchfulness, steel having been improved sufficiently to be generally used. The pipe in present use is nearly all steel, and lap welded. It is made so well that flanges can be turned cold without causing cracks or flaws. Seamless drawn pipe is also used, and flanges are welded to their ends, the most recent development in this direction being the upsetting of the ends of the tubes and forming the ends themselves into flanges that are integral parts of the tubes. Wrought steel pipe fittings are also available for steam pipes, and it is clear that the boiler, through the increase of steam pressure, is recognized as the vital factor in the cheapening of the cost of power.

Selected timber to the extent of 950,000 feet, board measure, was shipped to the German Government from San Francisco recently for use in the new war vessels. The pieces were from 24 to 54 feet long and 4 by 4 feet in section. They were absolutely free from knots and blemishes and cost 4.66 cents per foot, as compared with 2.75 cents per foot in the same market for ordinary lumber.

THE RESIGNATION OF WM. BUCHANAN, SUPERINTENDENT OF ROLLING STOCK OF THE NEW YORK CENTRAL RAILROAD.

Rumor has been busy for some months past with reference to the retirement of Mr. Buchanan from the position on the New York Central Railroad, which he has so long and honorably filled. The rumor was not credited by those who knew him well, but on April 22 it was announced that his resignation had been sent in and accepted by the Board of Directors. At that time probably only a very few of those most nearly associated with him knew of his intention to retire from active work.

He was born in Scotland on March 6, 1830, and is therefore in his seventieth year. His service with the New York Central Railroad began in September, 1849, and he has been in the employ of the company ever since, so that in a few months more he would have completed fifty years of continuous service.

His father was a blacksmith by trade, and after coming to this country was employed in the Burden Iron Works in Troy. His son William obtained work in the same establishment, where he was first employed in punching the old-fashioned railroad chair plates. Later he worked with his father in the blacksmith trade. Being ambitious to learn the machine business, the son left the Burden Works and obtained employment on the old Albany & Schenectady Railroad, now a part of the New York Central line. He remained there about two years and a half, when, as he said, he concluded that no career was open to him there, and he determined to try his fortune in New York. After drawing his pay and paying his debts and his fare to New York, he had \$1.25 left, with which he arrived in this city, which presumably was not as wicked then as it is now, or his capital of \$1.25 would not have gone as far as it did. He at once applied for employment at the shops of the Hudson River Railroad at the foot of West Thirtieth Street. These shops were then under the charge of Walter McQueen, who afterward became the head of the mechanical department of the Schenectady Locomotive Works. When Mr. McQueen learned where young Buchanan had been employed he asked him whether he could set the valves of a locomotive. "Our man," Mr. McQueen said, "has been trying for four days to set them on one of our locomotives, and they are not set yet." Buchanan said he had done that kind of work on the Albany & Schenectady road and thought he could do it in New York. He was then placed in charge of the work and in about three or four hours had the valves properly set. It must be remembered that in those days "setting valves" was considered a great mystery. His success in doing this work was his first start on the Hudson River—now part of the New York Central—Railroad, and, as before stated, he has remained in the employ of the same company or its successors ever since. Soon afterward he was made shop foreman.

When Mr. McQueen left the Hudson River Railroad to take charge of the Schenectady Locomotive Works he was succeeded by Mr. Waterman. A disagreement between him and Mr. Buchanan led the latter to ask for employment running a locomotive. He was engaged in that occupation long enough to become thoroughly familiar with the practical part of the management of locomotives, and this experience was of very great value to him all through his career.

Waterman being of an inventive turn of mind, and like many other inventors often more sanguine about the success of his inventions than his employers were, dissatisfaction on the part of the latter resulted and his resignation followed, and in 1853 Mr. Buchanan was asked to take charge of the Thirtieth Street shops as Master Mechanic. The scope of his authority was extended from time to time, and in 1881 he became Superintendent of Motive Power of the entire New York Central system. Subsequently the title of the position was changed to Superintendent of Motive Power and Rolling Stock, and some time afterward the West Shore line was leased by the New York Cen-

tral, the machinery department of the leased line was also placed under Mr. Buchanan's jurisdiction.

In the departments over which he had direct supervision between 7,500 and 8,000 men are regularly employed. It is doubtful whether any railroad man in the country, having authority over an equal number of men, has commanded their respect, confidence and feeling of personal allegiance to the same extent that Mr. Buchanan has, and the news of his resignation has been learned by them with profound feelings of regret.

Besides an intimate practical knowledge with all the details of construction and operation of railroad machinery, during all his career he has shown a remarkable clear and unerring discernment of the merits of mechanical appliances. His name became known the world over from the celebrated locomotive, No. 999, exhibited at the Chicago World's Fair, and which he designed and had built in the shops of the New York Central Railroad at West Albany. In his early days on the Albany & Schenectady road he did more or less work on the old pioneer locomotive, De Witt Clinton. Aided by some old drawings, he had a duplicate of this machine and three of the old cars used on that road built, which were also exhibited in Chicago, and attracted a great deal of attention.

A marked characteristic of his mind is conservatism, and he always seemed to have an unerring judgment in deciding whether any mechanical appliance was entirely practicable or not, and in the administration of the affairs, in the department over which he has had control, he showed a remarkable amount of skill and ability in producing maximum results with a minimum of expenditure. The system of management of the machinery department of the New York Central line and that of the Pennsylvania road are in many respects totally different. If some competent person should acquaint himself thoroughly with each of the two systems and make an analysis and comparison of their respective merits and demerits, it would be a work of the utmost value to the railroad companies of the country.

Mr. Buchanan has earned a rest, but those who have been favored with his acquaintance and friendship may perhaps now experience the same feeling of perplexity that American people generally feel about our ex-Presidents—that of finding a worthy occupation for him during the remainder of his life. Mr. Buchanan, though somewhat overworked, is still vigorous, and it is quite certain that in the years that remain for him—and may they be many—he will realize the truth of Joubert's remark, that "the residue of human wisdom purified by old age is, perhaps, the best thing we possess." M. N. FORNEY.

LARGE DREDGE FOR RUSSIAN CANALS.

A very large dredge, built by the Société John Cockerill, at Seraing, Belgium, for the Russian government, at a cost of \$559,700, is described by Consul Alfred A. Winslow, writing from Liege, as follows:

The dredge is constructed on the principle of the dredge Beta, in use in the Mississippi, but is very much larger, being able to remove 4,000 cubic yards of sand, gravel, clay, or similar material per hour to a distance of 700 feet. The earth is cut up and mixed with water by revolving trepans, until it is of a consistency that can readily be forced up by two powerful steam pumps of 1,428 horse power each.

The dredge is 214 feet 6 inches long, 61 feet 6 inches wide, and when ready for work, draws 4 feet 6 inches of water. It can excavate a channel nearly 80 feet wide and 14 feet deep at one cutting. The fuel used is naphtha, and when the dredge is in full blast, it consumes about 1,200 gallons per hour. Tanks are provided that hold sufficient fuel to run the dredge at full pressure for twenty-four hours. When in full operation, it will give employment to 36 men, as follows: Stewards, 6; engineers, 12; and laborers, 18.

The dredge will be given a trial on the River Scheldt, near Antwerp, Belgium. From there it will be towed to the vicinity of St. Petersburg, where it will begin its work.

ARTHUR M. WAITT.

WIRELESS TELEGRAPHY.

The appointment of Mr. Arthur M. Waitt to the position of Superintendent of Motive Power of the New York Central & Hudson River Railroad takes him from a leading position in charge of the car department of the Lake Shore & Michigan Southern to the first position in the motive power department of the Vanderbilt lines. He is in the prime of life, and has prepared for this important office by education, experience and most careful study of the problems of transportation which are constantly changing with the times.

He was born in Boston in 1858, and, after taking a degree in mechanical engineering at the Massachusetts Institute of Technology in 1879, he entered the service of the Chicago, Burlington & Quincy Railroad in the office of Mr. Thomas Potter at Burlington, and later served as draftsman in the car and locomotive departments until he entered the service of the Eastern Railroad at Boston in a similar capacity in 1882. In 1884 he became chief draftsman of the Eastern Railroad, and in 1887 was general foreman of the car department, and was soon appointed Assistant Master Car Builder of the Boston & Maine. In 1889 he was appointed Assistant Manager of the Pullman Works, but being broad and liberal-minded he could not confine himself long within the limits of a private car building establishment and left at the request of John Newell to return to railroad service as Assistant General Master Car Builder of the Lake Shore at Cleveland. In October, 1892, he was made General Master Car Builder, the position he now leaves.

Mr. Waitt combines a technical engineering education with marked ability and experience. He is a clear-headed business man and has been closely identified with the best improvements in car construction. His chief work has been in connection with cars and by keeping constantly in touch with all motive power subjects he is well prepared for the problems now before him.

In 1898 he was elected Third Vice President of the Master Mechanics Association, and for years has taken a prominent part in the discussions before the Master Car Builders' Association. Before the technical railroad associations and in the technical press his opinions have been frequently expressed and while often bold, they have also been properly conservative. He is a member of the American Society of Mechanical Engineers.

He is a very clear thinker, a thorough organizer, a reliable mechanical officer, with opinions and reasons for them, and is an honest straight forward man, who gives a great deal of attention to the moral influences surrounding those for whose work he is responsible. He is a staunch supporter of the Railroad Branch of the Young Men's Christian Association, which has had such a powerful influence for good among the railroad employees of this country.



ARTHUR M. WAITT,
Superintendent of Motive Power,
New York Central & Hudson River Railroad.

At a recent meeting of the Institution of Civil Engineers held in London Signor Marconi read a paper on "Wireless Telegraphy," which has attracted unusual attention.

The lecturer began by describing the apparatus employed. In the course of his description he said that a properly made coherer, though the contrary had sometimes been stated, was as reliable as any other electrical instrument. He emphasized the great importance of the vertical conductor used in his system, and attributed the success he had obtained to its employment. He had found that the distance to which signals could be sent varied according to the square of the length of this conductor. Thus a conductor 80 feet high could be used for signalling over a distance of 18 miles,

and he was confident that one 114 feet high would be sufficient to enable communication to be established between Folkestone and Boulogne, 32 miles apart. When such a vertical wire was employed no hindrance to the signalling was caused by hills and other obstacles or by the curvature of the earth.

As to the possibility of preventing messages sent by one station from being read by stations other than the one for which they were intended, Signor Marconi said that something could be done by the aid of synchronizing devices, two instruments not responding to each other unless properly tuned. By means of reflectors, too, an almost straight beam of electric rays could be directed in any desired direction, and he had found by experiment that at a distance of $1\frac{1}{4}$ mile a receiving instrument failed to act if it was more than 50 feet to the right or left of the supposed center line of the beam. This fact might, he suggested, be applied to the guidance of ships in thick weather. With reflectors he had not sent signals more than two miles, most of his attention having been given to the vertical wire system; but he was of opinion that it was possible to go much further in this way, and has since confirmed this.

He then proceeded to describe some of the installations of wireless telegraphy that had been successfully worked. Between Alum Bay and Bournemouth and later between Poole and Bournemouth—distances of 14 and 18 miles respectively—signals had been regularly exchanged, and the experience of 14 months showed that there was no kind of weather in England that could stop the working of the apparatus. Improvements in the construction of the instruments had enabled him to reduce the height of the vertical conductor to 70 feet for the distance between Poole and Bournemouth, and he expected to be able to make still further reductions. After referring to the installation set up between Ballycastle and Rathlin Island, and to the feat of reporting the progress of Kingstown regatta from a steamer accompanying the competing yachts, he went on to speak of the installation fitted up last autumn between the Royal Yacht Osborne and Osborne House during the Prince of Wales's illness. This gave an opportunity of studying the effect of intervening hills, and as the yacht moved about in various portions of the waters round the Isle of Wight doubts were set at rest as to the possibility of telegraphing across long stretches of land. Communication between lightships and the shore was a matter of great importance. The wireless system

had been in satisfactory operation since December between the South Foreland Lighthouse and the East Goodwin lightship—a distance of 12 miles—and had worked all through the recent storms without interruption, thus showing itself even more trustworthy than the land wires. As to wireless communication across the Channel, Signor Marconi said it would have been established long ago if the promised official consent of the French Government had been received, but information that this permission had been granted only reached him during the reading of his paper: [Since the paper was read the system has been successfully put into operation across the Channel between Folkestone and Boulogne.]

SHRINK AND FORCE FITS.

The relative merits of shrink and force fits have been considered uncertain and the difficulties of settling the question experimentally have rendered it a matter of experience and opinion upon which very little has been positively known.

The "American Machinist" of Feb. 16, contains an interesting article by Prof. J. J. Wilmore, of the Alabama Polytechnic Institute, on some experimental work of two Senior Class students in mechanical engineering, Messrs. Haralson and Wood. The experiments which formed the basis for their thesis, were made by forcing and shrinking steel spindles of nominally one-inch diameter, into cast iron disks, and noting the force required to pull some of them out, and to twist others in the holes. The holes were reamed to one-inch diameter, with an error believed not to exceed 0.00025 inch, while the spindles were ground to a diameter of 1.001, 1.0015, 1.002, 1.0025 and 1.003 inches. Below is given an abstract from the conclusions.

The following table shows the numerical results. It should be remembered that all the holes were one inch in diameter and one and one-fourth inches long, the variation in diameter being made in the spindle. It will be noted that the shrink fits are quite uniformly about three times as strong as the force fits of corresponding size, both in tension and torsion. The force fits were made without lubrication other than the small amount of machine oil adhering to the spindle on account of having been wiped with oily waste, after grinding, to prevent rusting. The spindles and holes were found to be smooth and in good condition after the tests. The maximum force was required to start the spindles. After movement had once occurred between the two surfaces, a much smaller force was required to start it a second time. No. 19 test piece was tried in torsion up to the limit of the scales without movement.

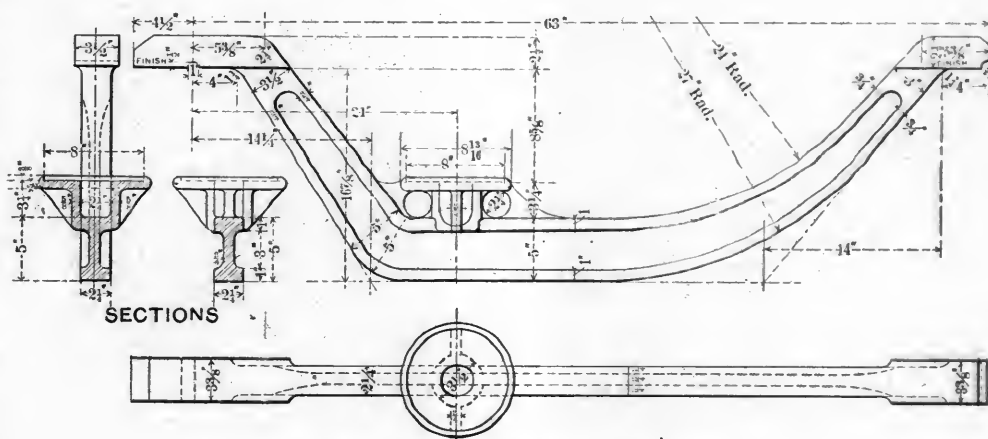
TABLE OF RESULTS.

Number of specimen.	Diameter of spindle. Inches.	Kind of joint.	Force necessary to start joint. Lbs.	Force per square inch. Lbs.	Kind of test.
1	1.001	Force.	1,000	318	Tension.
2	1.001	Shrink.	5,320	1,695	Tension.
3	1.001	Shrink.	5,820	1,853	Tension.
4	1.001	Shrink.	2,200	700	Torsion.
5	1.0015	Force.	2,150	685	Tension.
6	1.0015	Force.	2,200	700	Torsion.
7	1.0015	Force.	2,800	892	Torsion.
8	1.0015	Shrink.	7,200	2,290	Torsion.
9	1.0015	Shrink.	9,800	3,118	Torsion.
10	1.002	Force.	2,570	818	Tension.
11	1.002	Shrink.	7,500	2,385	Tension.
12	1.002	Shrink.	8,100	2,580	Tension.
13	1.002	Force.	4,200	1,335	Torsion.
14	1.0025	Force.	4,000	1,272	Tension.
15	1.0025	Shrink.	9,340	2,974	Tension.
16	1.0025	Shrink.	9,710	3,090	Tension.
17	1.0025	Force.	4,600	1,465	Torsion.
18	1.0025	Shrink.	13,800	4,335	Torsion.
19	1.003	Shrink.	17,000	5,410	Torsion.

The maximum tangential effort of 17,000 pounds obtained in the tests, would, with a coefficient of friction of 0.2, give a normal pressure of 85,000 pounds, or 27,070 pounds per square inch; a pressure well within the crushing strength of the metals employed. With greater difference between the diameter of spindle and hole, it might be necessary to force the spindle into a heated disk. It seems evident from these experiments that the shrink fit is the better of the two, but in practical work it is not always the best way, but the "good enough" way that is sought. If, therefore, the force fits are good enough and can be made more cheaply than shrink fits, they will be used in every case.

CAST STEEL EQUALIZERS FOR PASSENGER CAR TRUCKS.

The use of cast steel instead of wrought iron for passenger truck equalizers has been carried beyond the experimental stage by Mr. John Player, Superintendent of Machinery of the Atchison, Topeka & Santa Fe Railway, the design used on that road being shown in the accompanying engraving, which was made from a drawing furnished by Mr. Player of an equalizer for a six-wheel truck. The design was made to insure ample strength and with a view of obtaining satisfactory work in cast steel.



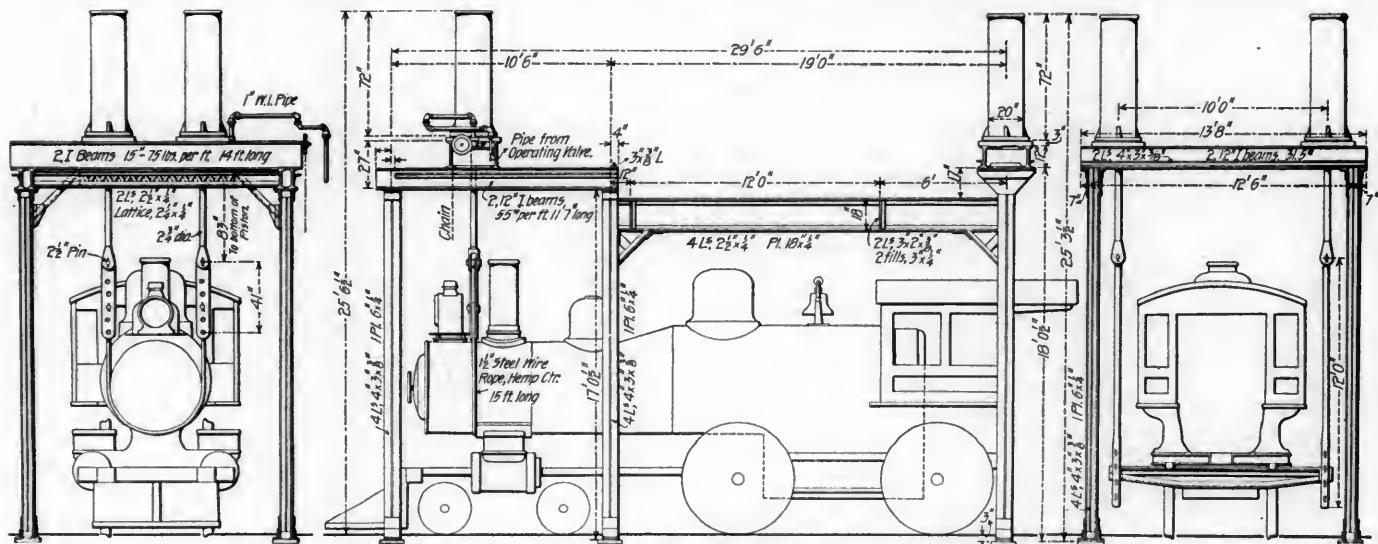
**Cast Steel Equalizer for Passenger Cars.
Atchison, Topeka & Santa Fe Railway.**

Except at the ends an I section is used, the web being $\frac{3}{4}$ -in. thick, with the depth varying from 3 in. at the light end to 5 in. at the spring seat. The drawing shows the dimensions and the construction throughout.

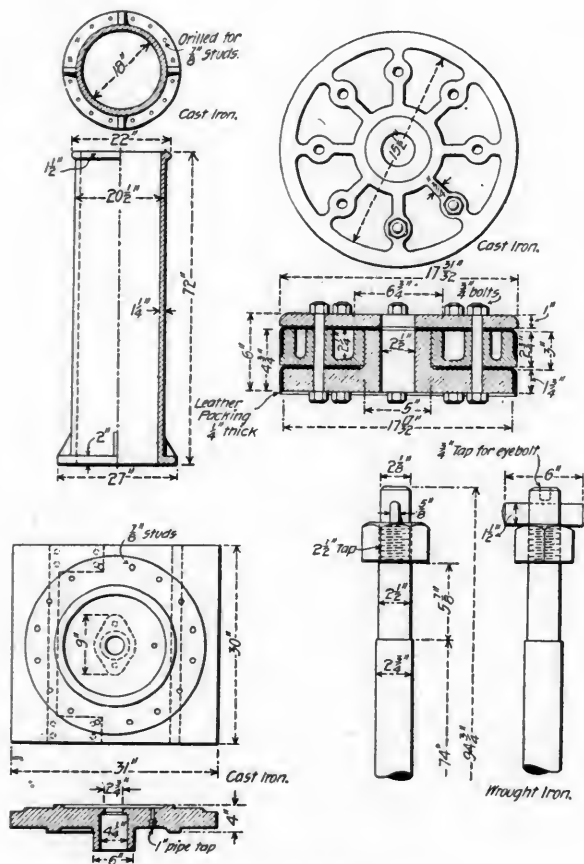
The equalizer as shown here was put into service in March of this year, after being submitted to severe tests in a testing machine, from which it appeared that the design was strong enough to stand the greatest load that they would be called upon to carry. They are now in use under eight heavy baggage cars, 60 ft. in length, and capable of carrying large loads, from which it appears that they are undergoing a severe test.

The chief advantages gained are less weight for strength equal to wrought iron, and a great saving in labor, due to absence of machine work. Mr. Player gives us the weight of this equalizer as 185 pounds, and of the equalizer spring seat 16 pounds, whereas the weight of the wrought iron equalizer which this one replaces was 210 pounds.

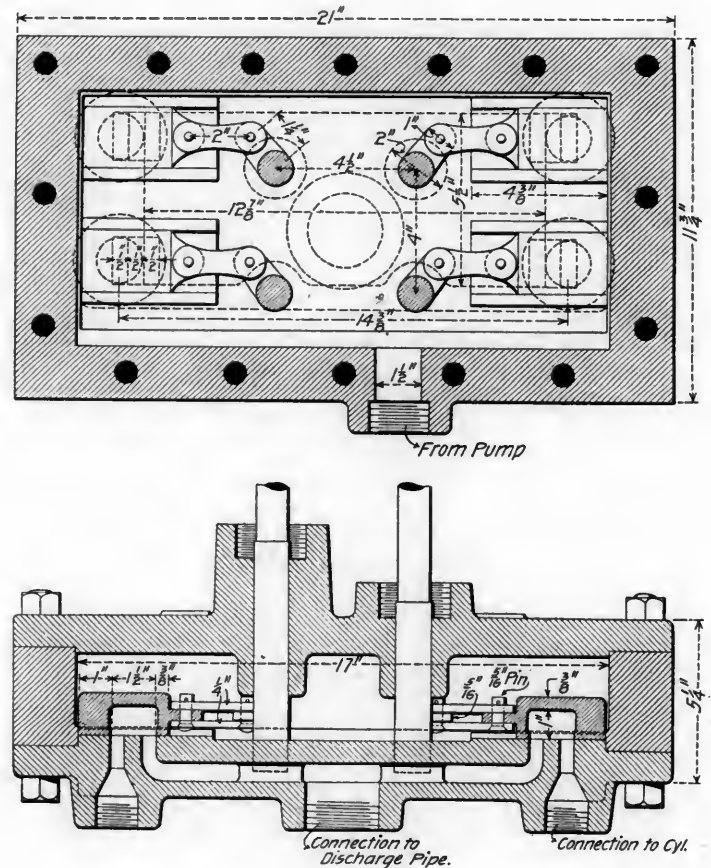
The Hyatt roller bearing has been awarded the Scott medal of the Franklin Institute. This bearing employs rollers in the form of spirally wound tubes, which are elastic. They do not break, and the committee reported a material reduction in the friction of the bearings by their use.



Hydraulic Locomotive Lift—Boston & Maine Railroad.



Cylinders and Pistons.



Operating Valve.

HYDRAULIC LOCOMOTIVE LIFT.

Boston & Maine Railroad.

A compact and inexpensive hydraulic lift for use in removing and replacing the driving wheels of locomotives recently built and installed at the Boston shops of the Boston & Maine Railroad is illustrated in the accompanying engravings. The object was to provide a hoist that would occupy the minimum floor space in an already over-crowded shop. The four hydraulic cylinders are mounted on a steel framework having six posts, the two cylinders at the rear end of the engine are fixed in position and are carried on transverse 12-inch I beams, while

those for the front end are mounted on 15-inch cross beams and are arranged to move laterally on these beams by means of a chain wheel and screw shaft, while the cylinder bearers may be moved longitudinally along the short panel of the frame for adjustment to the length of the engines. A 1½-inch steel wire rope is used as a sling under the smoke box extension, each end being coupled to a link suspended from the piston rod of one of the cylinders. The rear end is lifted by means of a plate girder 10 feet 8 inches long, made of a 2 by 12-inch wrought iron plate, to which 5 by 3½ by ½-inch angles are riveted on one side only. This plate is 12 inches deep for a length of 50 inches at the center, and tapers to a depth of 8 inches at the

ends. The cylinders are of cast iron $1\frac{1}{4}$ inches thick, 18 inches inside diameter and 6 feet long. They are shown in section in the engraving, which also illustrates the construction of the cylinder heads and pistons. The piston rods hang from the pistons and are connected directly to the slings. The hydraulic connections to the forward cylinders are made by flexible piping with joints made like those illustrated in the "American Engineer" of November, 1898, page 376. Power is supplied by a duplex steam pump formerly used in a locomotive water station and capable of giving a pressure of 125 pounds per square inch in the lifting cylinders. With this pressure the hoist will raise weights of 50 tons and it is obvious that the capacity may be increased by using higher pressure. The controlling valve is a very simple arrangement of four small slide valves, one for each cylinder. The valve spindles are provided with stuffing boxes, not shown in the engraving. We are indebted to Mr. Henry Bartlett, Superintendent of Motive Power, for the drawings.

PERSONALS.

Mr. Herbert Roberts has been appointed Superintendent of Motive Power of the Norfolk & Southern R. R.

Mr. J. M. Robertson has been appointed Assistant Master Mechanic of the Wabash R. R. at Ashley, Ind.

Mr. S. Phipps has been appointed Assistant Master Mechanic of the Canadian Pacific at Winnipeg, Man. He was formerly Road Foreman.

Mr. John Vought has been appointed Master Mechanic of the Mahanoy & Hazleton division, Lehigh Valley R. R., at Hazleton, Pa., succeeding Mr. F. Roth, resigned.

Mr. John Milliken, Assistant Engineer of Motive Power of the Philadelphia, Wilmington & Baltimore, has been appointed to a similar position on the United Railroads of New Jersey.

Mr. J. L. Mohun has been appointed to the position of Assistant Master Mechanic of the Juniata shops of the Pennsylvania Railroad at Altoona.

Mr. William Forsyth, Superintendent of Motive Power of the Northern Pacific, has resigned and will take a vacation for the benefit of his health.

Mr. R. W. Bayley, heretofore Assistant Secretary of the Westinghouse Air Brake Company, at Pittsburg, will succeed Mr. John W. Cloud as Western Representative in Chicago.

Mr. J. E. Button, Division Master Mechanic of the Chicago, Burlington & Quincy, at Ottumwa, Iowa, died March 13.

Mr. G. W. Dixon, heretofore Roadmaster of the Pittsburg, Lisbon & Western, has been appointed Master Mechanic of that road, with office at New Galilee, Pa., in place of Mr. Richard Beeson, resigned.

Mr. J. H. Pennington has been appointed Superintendent of Motive Power of the Delaware, Susquehanna & Schuylkill, with headquarters at Drifton, Pa., to succeed the late John R. Wagner.

Mr. L. F. Purtil, who for several years has been Mr. Parke's assistant as Eastern Representative of the Westinghouse Air Brake Company, will succeed Mr. Parke in charge of the New York office.

Mr. O. H. Crittendon, Assistant Engineer of Maintenance of Way of the Kansas City, Pittsburg & Gulf, has been appointed Chief Engineer of that system, with headquarters at Texarkana, Tex.

Mr. R. A. Parke, who for a number of years has been Eastern Representative of the Westinghouse Air Brake Company in New York, has been appointed Assistant Secretary, which will call him to Pittsburgh. He will be missed in New York.

Mr. O. J. Kelly has been appointed Division Master Mechanic of the Philadelphia, Baltimore and Valley divisions of the Baltimore & Ohio Railroad, with office at Riverside, Baltimore, Md.

Mr. Theodore Haberkorn, heretofore connected with the Motive Power Department of the Pittsburg, Fort Wayne & Chicago at Fort Wayne, Ind., has been appointed Master Mechanic of the Kenova shops of the Norfolk & Western.

Mr. S. M. Roberts has been appointed Acting Master Mechanic of the Brunswick & Western R. R. at Brunswick, Ga. He was formerly General Foreman of the Plant system at Waycross, Ga. He succeeds Mr. W. H. Dyer, transferred.

Mr. D. C. Moon, Superintendent of the Dunkirk Allegheny Valley & Pittsburg, has been appointed Superintendent of the Rome, Watertown & Ogdensburg, with headquarters at Watertown, N. Y., in place of Mr. E. G. Russell, resigned.

Mr. W. H. Stocks has been appointed Master Mechanic of the Chicago, Rock Island & Pacific, at Chicago, to succeed Mr. A. L. Studer, promoted. Mr. Stocks will be succeeded as Master Mechanic at Rock Island by Mr. R. D. Fiddler.

Mr. S. F. Forbes, Superintendent of the St. Paul shops of the Great Northern, has been appointed Purchasing Agent, with office at St. Paul, Minn., in place of Mr. J. W. Blabon, promoted.

Mr. A. L. Studer, formerly Master Mechanic of the Illinois division of the Chicago, Rock Island & Pacific, at Chicago, has been appointed Assistant Superintendent of Motive Power, to succeed Mr. J. W. Fitzgibbon. His office is at Horton, Kansas.

Mr. L. T. Canfield, formerly Master Car Builder of the Chicago, Rock Island & Pacific, at Chicago, has been appointed Master Car Builder of the Delaware, Lackawanna & Western, with headquarters at Scranton, Pa. He has had a wide experience and is well equipped for the position.

Mr. William Hutchinson, Master Mechanic of the Chicago & Northwestern, at Eagle Grove, Iowa, has been appointed Master Mechanic at Winona, Minn., to succeed Mr. William McIntosh, and is succeeded as Master Mechanic at Eagle Grove by Mr. J. F. Fleisher, Foreman of the shops at Winona.

Mr. Robert McKenna, who has been Master Car Builder of the Delaware, Lackawanna & Western since June, 1870, has resigned. He is 72 years of age and has been in railway service since March, 1853. He was for 17 years foreman of the car shops of the Hudson River Railroad before going to the D. L. & W.

Mr. Joseph Elder has resigned as Master Mechanic of the Rock Island & Peoria at Peoria, Ill. He has been in charge of the machinery and rolling stock of the road since 1877, and from 1871 to 1877 was Master Mechanic of the old Rockford, Rock Island & St. Louis, now a part of the Chicago, Burlington & Quincy.

Oliver H. De Young, Master Mechanic of the Galveston, Harrisburg & San Antonio Railroad, died recently at El Paso, Texas. Mr. De Young entered the railroad service in 1875 with the Texas & New Orleans.

Mr. W. N. Cox has been appointed Acting Master Mechanic of the Alabama Great Southern Railroad, succeeding C. Skinner of Birmingham, Ala., resigned.

Mr. G. W. Dixon has been appointed Master Mechanic of the Pittsburg, Lisbon & Western, with headquarters at New Galilee, Pa. He succeeds Mr. Richard Beeson, resigned.

Mr. E. H. Harriman, Chairman of the Executive Committee of the Union Pacific, and a member of the Board of Directors of the Illinois Central, has been elected President of the Chicago & Alton, to succeed Mr. T. B. Blackstone.

Mr. C. A. Seley has been appointed Mechanical Engineer of the Norfolk & Western Railway, to succeed Mr. G. R. Henderson. Mr. Seley has been connected with the mechanical department of the Chicago Great Western Railway for several years.

Mr. John Forster has been selected to succeed Mr. J. S. Turner as Superintendent of the Union Pacific, Denver & Gulf Railway at Denver. Mr. Forster was formerly Master Mechanic of the Atchison, Topeka & Santa Fe at La Junta, Col

Mr. H. W. Kimball, of the Cleveland City Forge & Iron Co., died March 9, at the age of 54 years, in Cleveland, Ohio. He was President of the Chapman Jack Co. and held an interest in the Butler Drawbar Attachment Co. He was a very successful business man, a great part of which was due to his unusual mechanical ability and farsightedness. His friendships were numerous and strong.

Mr. George W. Bartlett, Division Engineer, New York Central & Hudson River Railroad, has been appointed Superintendent of the Dunkirk, Allegheny Valley & Pittsburg, a part of the New York Central system, with office at Dunkirk, N. Y., to succeed Mr. D. C. Moon, who has been promoted. Mr. Bartlett's experience in the operating department has been wide and he is well equipped for the position.

The Pennsylvania Railroad Company has announced the appointment of the following engineers and assistants: Alex. Kearney, Assistant Engineer of Motive Power; D. N. Perine, Assistant Engineer of Motive Power of the Philadelphia and Erie and Northern Central; Jos. T. Wallis, Assistant Master Mechanic of the Meadows shops; L. T. Ford, Assistant Engineer of the Elmira-Canandaigua division on the Northern Central; S. Shober, Jr., Assistant Engineer of the Tyrone Division.

Mr. J. S. Turner, whose appointment as Superintendent of Motive Power of the Union Pacific, Denver & Gulf Railway, now known as the Colorado Southern, at Denver, was noted in our December issue of last year, has resigned that position to become Superintendent of Motive Power of the Fitchburg Railroad, with headquarters in Boston. His jurisdiction will extend over all matters pertaining to the locomotive department. Mr. Turner was formerly Superintendent of Motive Power of the West Virginia Central & Pittsburg, and began his railroad service on the Pennsylvania at Altoona. He is well fitted both in ability and experience for his new position, and the appointment is heartily commended.

Mr. John W. Cloud's resignation as Western Representative of the Westinghouse Air Brake Co., at Chicago, was announced after we had gone to press last month. He goes to London in the interests of the Westinghouse brake and we understand that he will be permanently located there. We can not think of any one who will be more generally missed than Mr. Cloud. For ten years he has been Secretary of the Master Car Builders' Association, and for four years of the Master Mechanics' Association also. His place in these organizations can not be as well filled by any one else. From a somewhat selfish point of view it is to be regretted that his abilities take him elsewhere.

Mr. T. B. Blackstone has retired from the Presidency of the Chicago & Alton on account of the rule of the road. He was elected President of the road in 1864 and has held the position continuously. His railroad work began in 1847, on the New York & New Haven road, as a rodman. From October, 1848, to December, 1849, he was Assistant Engineer on the survey and construction of the Stockbridge & Pittsfield, and from the latter date to April, 1851, Assistant Engineer of the Vermont Valley. He then came west and accepted the position of Division Engineer of the Illinois Central, which he held until December, 1855. He was made Chief Engineer of the Joliet & Chicago in 1856, and had charge of the construction of that road and its maintenance after completion, being chosen President in January, 1861. This road was absorbed by the Chicago & Alton, and Mr. Blackstone was chosen President of the latter in April, 1864.

Mr. Walter Katté who has been Chief Engineer of the New York Central & Hudson River Railroad for the past thirteen years, has resigned and will serve as Consulting Engineer. He was born in London in 1830 and prepared for the engineering profession in an engineer's office in England. Since 1850 he has been in railroad and allied service and has made an enviable record. Among the roads that he has been connected with are the Pennsylvania, the Central of New Jersey, the West Shore, the New York, Ontario & Western, and the New York Elevated, as well as the New York Central. In addition to his railroad work he has had charge of the western business of the Keystone Bridge Company for ten years ending in 1875, and he superintended the construction of the Eads Bridge at St. Louis. For six years he was Chief Engineer of the West Shore, including the period of its construction. Mr. Katté is widely known and has had a remarkable career in connection with very large engineering undertakings.

Mr. W. J. Wilgus has been appointed to succeed Mr. Walter Katté as Chief Engineer of the New York Central & Hudson River Railroad. He is thirty-three years of age and though a young man he is fitted by a wide and varied experience for this important position. He was born in Buffalo, New York, in 1865, and after securing a school education he spent two years in the study of engineering. In 1895 he entered the service of the Minnesota & Northwestern as rodman, and after five years he went to Kansas City, in charge of important work in connection with the terminals at that point. In 1891 he went to Chicago in the capacity of Resident Engineer of the Chicago Union Transfer Railroad, and in 1893 he entered the service of the New York Central as Assistant Engineer, Maintenance of Way of the Rome, Watertown & Ogdensburg. Since that time he has held important positions in the engineering department, under Mr. Katté, and is now, as Chief Engineer, placed in charge of construction and maintenance of way of all the New York Central lines.

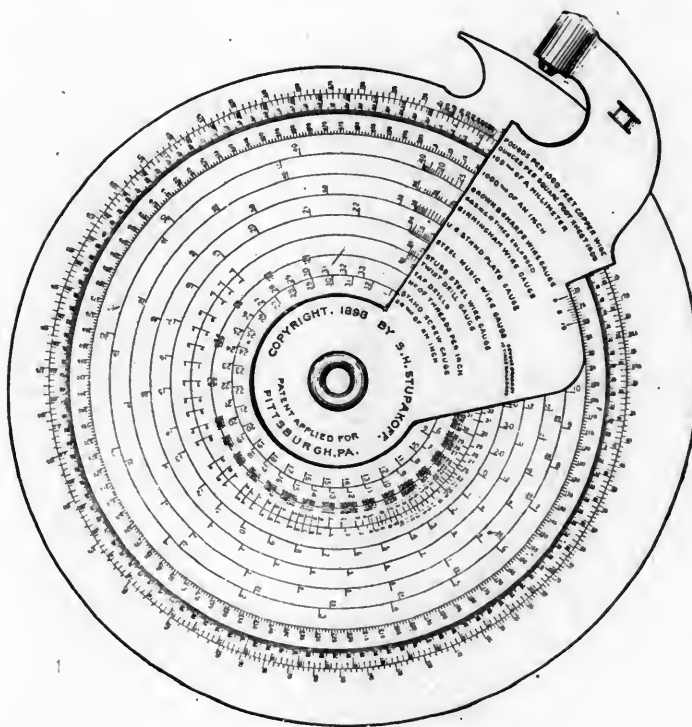
The American Society of Mechanical Engineers will hold its 39th meeting at Washington, D. C., May 9th to 12th, at the Arlington Hotel Assembly Room. The list of papers is as follows: "Standards for Direct Connected Generating Sets," by J. B. Stanwood; "Boiler and Furnace Efficiencies," by R. S. Hale; "Test of a Steam Separator," by F. L. Emory; "Investigations of Boiler Explosions," by G. C. Henning; "Equipment of Tall Office Buildings," by R. P. Bolton; "Heating Plant of University of Wisconsin," by Storm Bull; "Power Plant of a University," by E. A. Darling; "Plunger Elevators," by G. I. Alden; "Elevators," by C. R. Pratt; "Allen Valves for Locomotives," by C. H. Quereau; "Rolling Mill Fly Wheels," by John Fritz; "Valves for Steam Engines," by F. W. Gordon; "Manufacture of Car Wheels," by G. R. Henderson; "Belt Tensions," by F. L. Emory; "Tests of Fire Hydrants," by C. L. Newcomb; "Deep Well Pump Rods," by G. W. Bissell; "Pipe Flanges and Bolts," by A. F. Nagle.

STUPAKOFF'S COMPAROMETER.

A brief description of an ingenious measuring instrument devised by Mr. S. H. Stupakoff, Superintendent of the Union Switch & Signal Co., Swissvale, Pa., known as Stupakoff's Comparometer, was given in our issue of April, 1898. We are now enabled to illustrate and describe it more fully.

The comparometer combines a micrometer caliper, of English and metric division, with various current gauges for wire, plate, drills, etc.; it gives the weights for round and sheet metals, the number of threads per inch for standard machine screws and suitable tap-drills therefor, and furnishes the means for comparing any or all of these data at a glance. The mechanical principle involved in the comparometer is that of a plane spiral base combined with a radius vector, movable around its pole. A shifting of the radius vector causes some fixed point on it to recede from or to advance toward the spiral. The rate of recession or advancement is in direct proportion to the arc traversed.

The pitch of the spiral in this instrument is one-half inch, and the space between the circumference of the base and the



Stupakoff's Comparometer.

adjusting screw of the radius vector or indicator arm gives an equivalent range of measurement. The readings corresponding to the absolute measurements of the comparometer caliper are tabulated on the base, and they are found, in each instance, in a radial line with the micrometer screw along the beveled edge of the indicator arm. The latter bears the descriptions for the divisions on the base and a vernier for the inch scale. The indicator arm is equipped with an adjusting screw in the same plane with the spiral edge of the base, and at right angles to its tangent.

The divisions on the base are described on the indicator; they represent in all cases a limit between 0 and $\frac{1}{2}$ inch for the whole revolution. All numbers relating to the divisions on the base are marked above their respective division lines, which facilitates their reading without shifting the indicator.

The Brown & Sharpe wire gauge circle is provided with double divisions. The divisions on the outside of the circle are in direct proportion to the inch and the metric circle. The divisions on the inside, however, are tenfold enlargements of

the former; they add, therefore, another decimal to the inch and metric scales, when compared therewith.

The steel music wire gauge, representing numbers from 8-0 to 30, and ranging in size from .0083 to .080 inch, is located on the fourth smallest circle. Its readings on the first portion of the circle, which are connected by a bracket, may be directly compared with any of the other gauges or scales on the dial. The reading on the inch circle, compared therewith, will give, therefore, dimensions in three decimal places, the fourth one being found with the aid of the vernier.

The Stubbs steel wire and the twist drill gauges, being nearly alike, are marked on one common circle, the one outside and the other inside of the same. The gauge lines and numbers of the American standard screw gauge are placed on the outside of the smallest circle; their corresponding dimensions or diameters are found radially in line therewith on either one of the scale circles; the number of threads to the inch and number of tap drills occupy the space on both sides of the next to the smallest circle. The notations on the inside of the smallest circle give the relative values of the above dimensions in 64ths of an inch. Those outside of the outside circle give the weight of 1,000 feet of copper wire in pounds; while those on the inside of the same circle give the weight in ounces for each square foot of sheet iron. Its use may be illustrated by the following example:

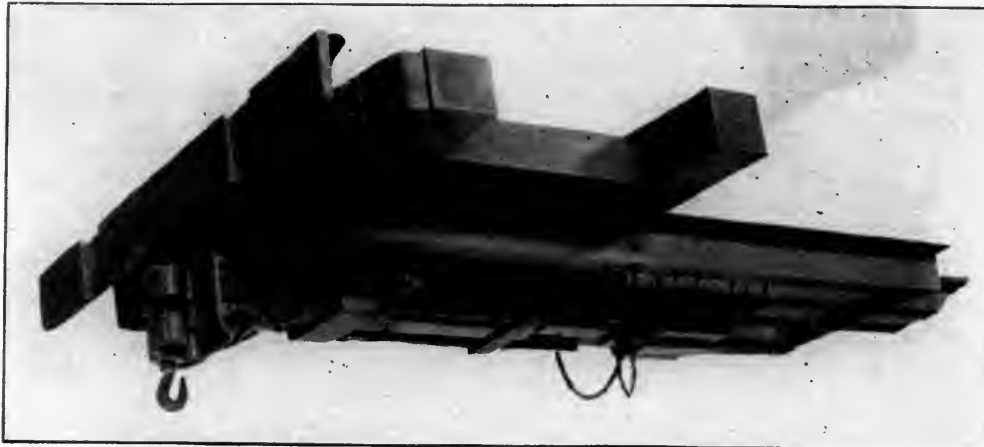
Assuming that a piece of copper wire is specified to measure 0.508 mm. The straight edge of the indicator is brought in alignment with this value, whereupon all the corresponding values are found along the radial line, which is indicated by the straight edge on the base. These are as follows:

- .508 mm.
- = .020 inches.
- = No. 25 B. W. G.
- = No. 24 (-.0001 in.) Brown & Sharpe Wire Gauge.
- = 75 Stubbs steel wire and twist drill gauge.
- = No. 5 (-.0002 in.) Steel music wire gauge.
- = 1.24 lb per 1,000ft. (copper wire).

Assuming that we have a piece of copper wire concerning which all possible data is required. It measures No. 4 B. & S. wire gauge and the simultaneous readings are:

- 13-64 inch.
- No. 11 standard machine screw.
- 24, 28 or 30 threads per inch.
- No. 21, 20 or 19 tap drill.
- No. 26 twist drill gauge.
- No. 5 Stubb's steel wire gauge.
- No. 6 B. W. G.
- 0.2043 inch.
- 5.19 millimeters.
- 126½ lbs. per 1,000 feet (copper wire).

A statement of fuel costs on the Lake vessels, owned by the Cleveland-Cliffs Iron Company and used for transporting iron ore, is published by the Cleveland "Marine Review," and serves as some index to the low cost of transporting freight on the Great Lakes. These steamers are of moderate size and have not all the improvements introduced in the great freighters built during the past year, but the fuel cost on them seems extremely low. Thus, on one vessel, which made 26 round trips—32,866 miles in all, at an average speed of 10.05 miles an hour—the fuel cost was only 11.16 cents a mile. On another, which made 33 trips—41,009 miles in all—the cost was 11.86 cents a mile run. In this case the speed was a little higher, the average being 12.12 miles an hour. The average cost of fuel per ton-mile on these ships was 0.00279 cent and 0.002965 cent respectively. In both cases the fuel cost less than three one-thousandths of a cent per ton-mile. We do not believe that any such fuel costs can be shown anywhere else in the world, and yet on the Lakes they are called rather high. We may add that the average cost of coal on board was \$1.89 a ton. We are assured that on the new boats carrying 7,000 to 8,000 tons, and furnished with quadruple expansion engines, much better results can be secured, and will be shown during the coming season.—"Engineering and Mining Journal."



The Gould Steel Platform for all Cars in Passenger Service.

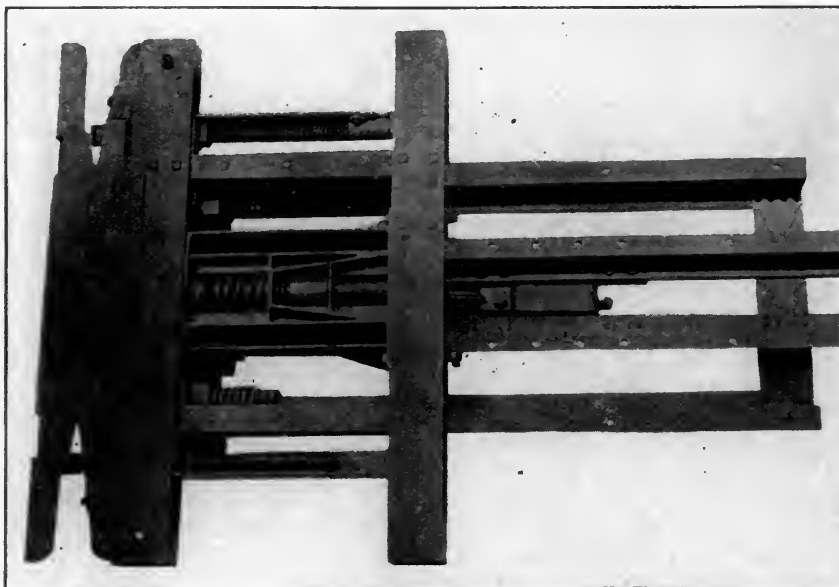
THE GOULD STEEL PLATFORM.

A new steel platform recently perfected by the Gould Coupler Co. and adapted for use on cars with wide or narrow vestibules or without vestibules and also to baggage and express cars, is shown in these engravings.

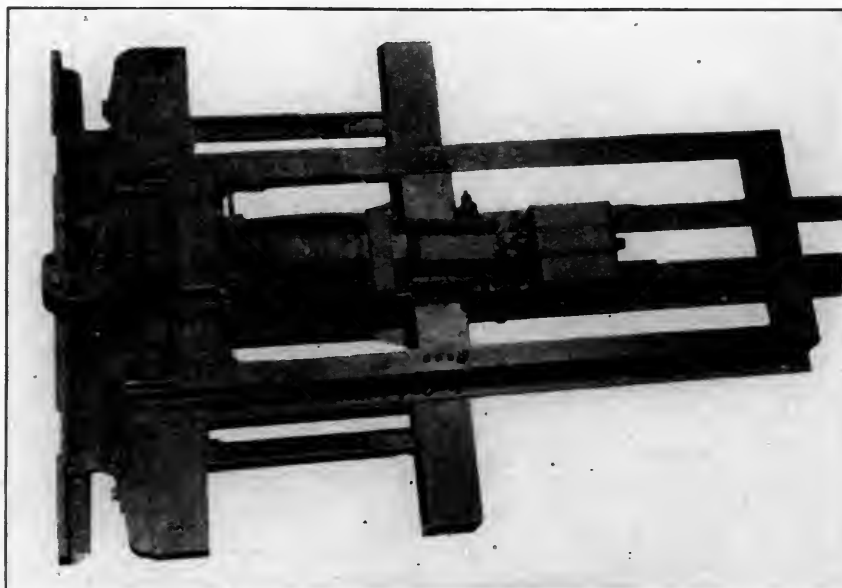
Instead of I beams, Z beams are used in this construction, this selection having been made with a view of securing the greatest lateral stiffness. The upper flanges are turned toward the outside and the wide flanges offer good opportunities for fastenings. There are two central Z beams, outside of which are two shorter ones. These are well tied together by three steel plates, which are riveted to the lower flanges of the central Z beams and to the top faces of the lower flanges of the outside pair. The top flanges of the longitudinal members are tied together by their attachment to the platform and car sills. The draft gear is arranged to be removable without taking out any of the through bolts. The whole arrangement of the draft gear is such as to relieve the bolts from improper stresses. The bolts for the drawbar guides pass through the draft castings and also through the lower flanges of the central Z beams. The drawbar castings are of malleable iron and the flanges of the Z beams are protected by them from the wear of the followers.

The drawbar carry iron is held laterally by abutting against the lower flanges of the outside Z beams, which relieves the bolts from shearing stress. The steel beams are securely bolted to the end sills and also to the longitudinal sills. The buffing stresses are taken by a malleable iron buffing casting bolted to the top flanges of the center beams and fitted between the platform end sill and the end sill of the car. This forms a solid abutment to receive the compressive stresses and provides for them in a direct line where the resistance is greatest. This feature relieves the bolts and should have a marked influence on the life of the structure.

The platform is simple and easy of access, the parts likely to need removal being designed with this in view and also for easy inspection. It is adapted for use with the



The Gould Steel Platform—Top View.



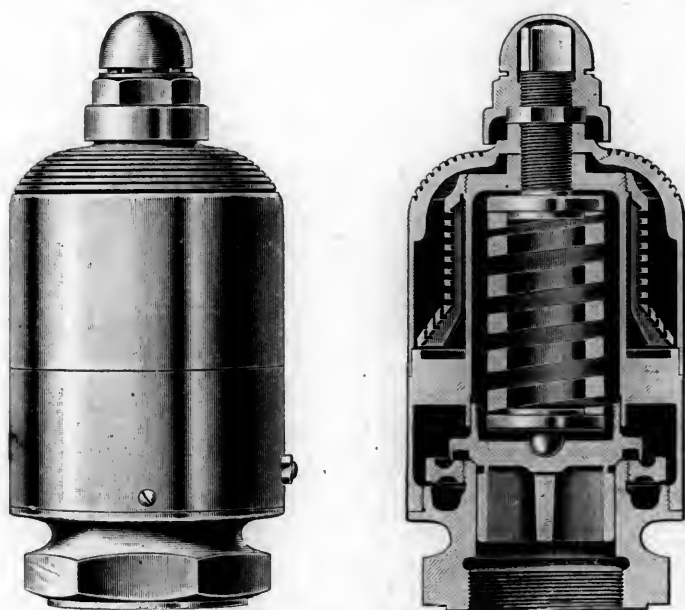
The Gould Steel Platform—Bottom View.

Gould continuous buffer and coupler without changes and where these devices are now used with wooden platforms, these parts remain standard and are interchangeable with parts used with the steel platform. We are informed that this platform is no heavier than the corresponding parts of the Gould standard wooden platform. It is an important improvement especially considering its adaptability to so many different types of cars.

LOCOMOTIVE POP SAFETY VALVES.

Pop valves designed and made specially for locomotive use by the Star Brass Manufacturing Co., of Boston, are illustrated by the accompanying engravings, which show an exterior and a sectional view.

The section drawing gives a clear view of the construction of the valve, which is strong and heavy to withstand high pressures. The material, we are told, is of the best obtainable. The springs are made of the best grade of Jessop's steel, im-



Locomotive Pop Valves.

ported from Sheffield, England, specially for this purpose. They are made and tempered separately and are ground separately with a view of securing perfect work at the ends. They are thoroughly tested under high pressures before being placed in the casings, in order that any possible permanent set may be discovered before they are placed in service. The springs are fitted between pivoted spring discs, to prevent the valve from cocking or tilting. The spring is enclosed in a chamber and perfectly isolated from the escaping steam, which has a tendency to rust the spring and spoil its temper. The muffer is slotted, which is a novelty used in these valves only, and a feature that is considered by these manufacturers as the most perfect muffer to be found, and much better than the form in which the passages are round. A very large power of relief is also claimed as an important attribute of this design, to which the possibility of close adjustment of the range of "pop" while securing full relief of the boiler are added.

These valves are made in sizes from 2 to 3½ inches inclusive. Its adoption upon some of the most important railway systems is good evidence of merit. The address of the Star Brass Manufacturing Co. is 108 East Dedham St., Boston Mass.

The Wooten Boiler, Its Origin, Construction and Advantages, was the subject of a very interesting and instructive illustrated lecture by Mr. S. M. Vaclain, at the April meeting of the New York Railroad Club. The general use of this type of boiler was predicted, chiefly on account of its adaptability to the use of low grades of fuel. The large grate area was advantageous and increased the boiler power to a remarkable extent. The type was advocated in its improved forms.

THE PEARSON CAR REPLACING JACK.

This simple implement consists of two sockets swiveled to a pair of elongated sleeves which form nuts to receive a spindle having right and left hand threads and fitted with a ratchet which is operated by a lever. The success of the device is due to its efficiency and convenience. The jacks are very compact and very light in weight for the duty they perform. With them a car may be lifted and moved bodily, by placing them at an angle so that as they lift the car they also tend to push it in the desired direction; they are also used for replacing locomotives.

The introduction of these jacks was started in Boston, in November, 1897, on 32 railroads, and in one year the list grew to 125 roads, including the strongest and most progressive in the country. It has also been found necessary to establish a factory to make them in Canada, at Montreal. They are also in use in England, Germany, Russia, Japan, Australia, New Zealand, Mexico and the South American Republics. We have seen a number of letters from railroad men who have used them for locomotives and cars, which make it evident that they offer great advantages over the ordinary jacks for replacing rolling stock on the rails.

SUPERHEATING OF STEAM.

At a recent meeting of the Northern Society of Engineers, Mr. Paul Schou traced the history of superheated steam from the beginning and gave its later development in an interesting paper, of which the following is an extract:

Two serious losses follow the use of saturated steam, one of which is a limited range of temperature and the other is cylinder condensation. To reduce these losses two remedies are used; one of these is the steam jacket on the cylinder to raise its temperature, and the other to expand the steam in two or more cylinders, thereby reducing as much as possible the difference in temperature between the admission and exhaust steam. A third method may be used; namely, to superheat the steam so that (a) the ratio of sensible heat to total heat may be increased, and (b) considerable reduction of temperature may occur in the cylinder before reaching the point where condensation begins. Heat is transmitted from steam to water with such a rapidity that the late Mr. P. W. Willans was disposed to attribute the phenomenon of initial condensation almost entirely to the presence of water. Whether this theory is correct or not, the fact remains that the adoption of a high degree of superheat practically eliminates initial condensation. The exposed surfaces of iron remain and the steam is there as usual, but there is no water, for the simple reason that the walls of the cylinder are maintained hotter than the saturation temperature of the steam in contact with them. The practical effect of a and b taken together as follows:

A triple expansion engine, working with 180 pounds steam pressure, may, under favorable conditions, produce one horse power with 12½ pounds of steam. The same steam, superheated 150 degrees Cent, will, in a compound engine, produce one horse power with 8¾ pounds of steam. The initial saving in heat units is 22½ per cent., and it would be possible to get the same efficiency in a compound engine working with 11 atmospheres pressure as in a quadruple expansion working with 25 atmospheres pressure. Superheated steam has another great advantage, in that its specific volume is greater than saturated steam of the same pressure. If there are, therefore, two cylinders of exactly the same size, both working with the same degree of expansion, the weight of steam will be less in the cylinder working the superheated steam. The volume increases in proportion to the superheat. The more the superheat, the less steam is used per horse power.

The total railroad mileage of the United States is said by Mr. Mulhall, an eminent English statistician, to be nearly half that of the entire world, there being 182,776 miles of railroad exclusive of side tracks in the United States, as against 436,240 miles as the world's total. The freight tonnage carried by our railroads is more than one-half that carried by the railroads of the world. The United States in 1892 carried 845,000,000 tons of freight 100 miles, as against 1,348,000,000 tons carried by the world the same distance, or 503,000,000 tons carried by the balance of the world.

THE BROWN PYROMETER.

Mr. Edward Brown, of Philadelphia, Pa., has devoted his attention for about 30 years to the manufacture of pyrometers and has sent us a brief review of the history of the use of these instruments, from which the following paragraphs are taken:

The original stationary pyrometer, having an appearance identical with those in common use to-day, was patented about 1850 in England. The stem was of metal, brass and iron. This style was made and sold in the United States, and though much overrated as to its suitability for high temperatures, it had considerable sale for bake ovens, and if inserted always to the same depth, was fairly accurate up to 600 degrees. It held its place as the only available instrument up to 1870. About this time the blast from iron stoves was much raised in tem-

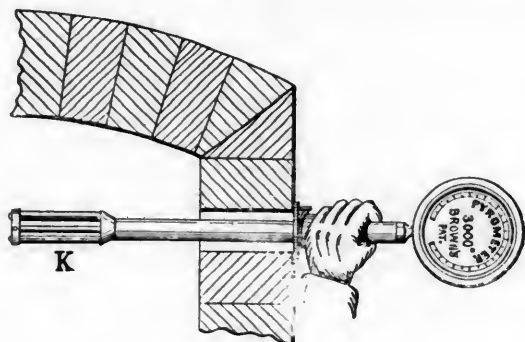


Fig. 1.

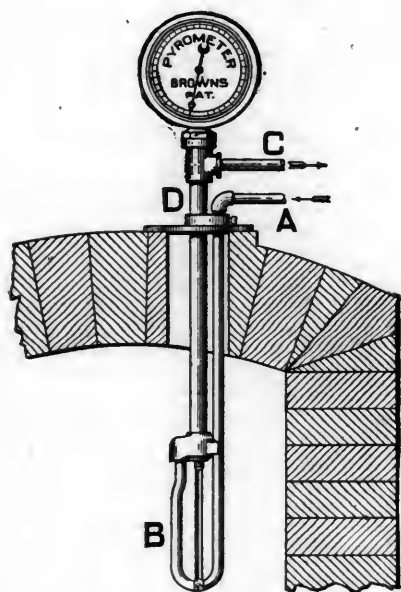


Fig. 2.

perature, occasionally running up to 1,000 degrees, and the demand was great for an indicator for this temperature. In 1870 Mr. Brown brought out his graphite stem pyrometer, which was still further improved in 1872 by making the inside rod of the stem above the graphite of the same metal as the stem, so that the stem could be inserted to varying depths and still indicate nearly accurately. This form of pyrometer soon became the only one in general use. With the advent of brick stoves producing a temperature up to 1,500 degrees, the most available instrument for many years was Brown's portable pyrometer, in which a mixture of hot and cold air imringed upon the expansion bar. An earlier instrument, Hobson's, on the same principle, in which the diluted blast was thrown against a thermometer, was generally used in England and the Southern States. Also Siemens' water pyrometer has been used to a considerable extent for temperatures up to 1,800 degrees.

Mr. Brown's water current pyrometer came in 1895. It is easy to see from Fig. 2 how naturally one invention developed

or evolved into the other. It only required the heavy solid frame K of the annealing oven pyrometer to be kept from melting off, and a stationary pyrometer to 3,000 degrees was accomplished. This was done by running a stream of water through it. This pyrometer must not be confounded with water current pyrometers, in which a pipe carrying a current of water is led through a furnace and the temperature of the water indicated by a thermometer. A prominent defect in all pyrometers based on the latter principle and usually overlooked is this: A current of heated gas or air at 2,000 degrees passing over a water pipe at a given draft of velocity, will heat it much hotter if passing at twice the velocity. Theoretically this must be the same with air circulating in place of water, though the error must be far less than with a liquid. This is provided for by Mr. Brown in the rod which passes from the expansion strip to the pointer. This rod takes its temperature from the water current, and serves to neutralize any error due to a rise or fall in the temperature of the frame D. The entrance for the water is at A. It flows through the bend B, up to D, and leaves the instrument at C. The indication needle is connected by a rod to the platinum expansion bar. This instrument is also made recording.

In 1896 Mr. Brown made his stationary hot blast pyrometer recording by means of special mechanism and clockwork. A pyrometer is subject to frequent handling, and it is important that the head, containing the recording chart, should be small and at the same time the degrees be large enough to indicate the fluctuations plainly. The indicating mechanism must also be so connected to the stem that the powerful expansion and contraction will not damage the delicate mechanism of the head. The accompanying chart shows how well this is carried out, only the degrees from 700 to 1,500 degrees are marked on the

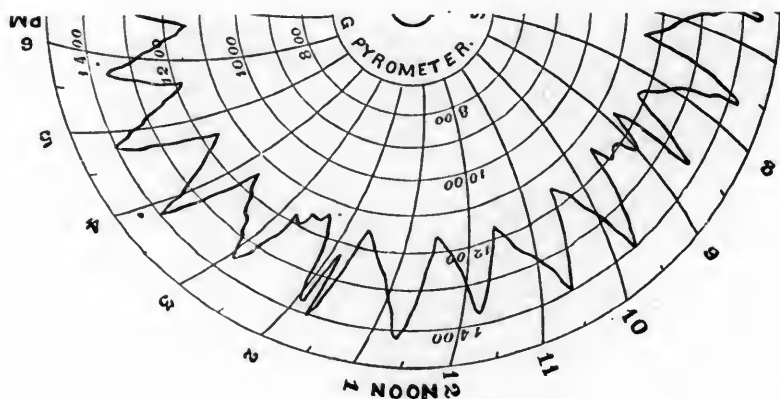


Fig. 3.

chart, this being the extreme of the range likely to be of service in blast furnace practice. These instruments are also useful for blast furnace downcomer pipe, and for recording the temperature of the escaping gas from steam boilers:

The value of recording devices is every year more appreciated. Instruments for this purpose have been for many years in extensive use, chiefly for steam pressures and low temperatures. We have only to go back perhaps 8 or 10 years to find the time when no recording chart was to be had of a temperature of 1,400 degrees. Fig. 3 shows a portion of a chart taken from a furnace probably without admixture of cold blast. The extremes of temperature are well defined. These charts indicate the exact time of changes of the furnace conditions. Their value in boiler tests is obvious.

Mr. Brown's pyrometers are all marked by great simplicity of construction; a very important feature when they are to be placed in the hands of ordinary workmen and laborers. The Franklin Institute of Philadelphia in 1897 awarded to Mr. Brown the John Scott Legacy Medal and Premium "for improvements in pyrometers." His address is 311 Walnut St., Philadelphia, Pa.

THE GRAHAM BRAKE EQUALIZER.

This device was designed to provide supports for the brake shoes of car trucks, in such a way as to carry the thrusts upon the journal boxes, instead of transmitting them to the truck frames, by means of hangers. The object was to prevent the tilting of the trucks and the sliding of the wheels. The brake hangers are attached to the ends of bent levers, which are fulcrumed in slotted lugs cast on the inside edges of the spring caps, and are provided with bearings on the inside edges of the top faces of the axle boxes. The end of one of these levers

of the Schuylkill and within easy access of the City Hall in Philadelphia. The object is to afford means for promoting international commerce and by exhibits of products and processes of manufacture to aid manufacturers and purchasers to come together for the discussion of topics of interest in international trade. The buildings provide more than eight acres of exhibition space. Light and power may be obtained from a power plant which is included. The exhibits will embrace foreign as well as home products, and the important subject of the proper method of packing and marking goods for foreign shipments is to be illustrated by aid of models. This is a more important matter than appears at first thought, because of



Truck Equipped with Graham Brake Equalizer.

is shown in the engraving of a four-wheel passenger truck fitted with this equipment. This suspension relieves the truck frames from the stresses tending to tilt them, and the brake shoes therefore are maintained at a constant height with reference to the center of the wheel. There is a further advantage in this method in that the brake thrusts do not add to the loads on the forward springs of the trucks upon the application of the brakes.

A severe service trial of this equipment was made recently under the direction of Mr. W. F. Stark, Superintendent and Joint Representative of the "Big Four," P., C. C. & St. L., Erie and Cincinnati, Hamilton & Dayton roads at Dayton, Ohio. We are informed that the device was applied for the purpose of preventing flat wheels, and that it was entirely successful. The trial took place on the Dayton & Union division of the "Big Four," between Dayton and Union City, a distance of 47 miles. There are 21 regular stops, and the time is 1 hour, 44 minutes for the trip. A round trip was made over this division with a baggage car and two coaches, fully equipped with the equalizers. The trip one way required 21 stops, of which one was a sharp one at a water tank, and in returning 25 stops were made. There were no cases of wheels sliding and not the least suggestion of a tilting movement of the trucks in the most severe stop. It is stated to be the intention of the road to continue and extend the use of the equipment. Four more cars are now in the shops to receive it.

Mr. J. Hector Graham, General Manager of the Safety Appliance Company, controlling the equalizer, states that in a test made on a baggage car when in a blinding snow storm, last March, it was shown to be impossible to slide the wheels, and he quotes from a letter from Mr. Stark concerning the device, as follows:

"So far it is giving satisfaction in preventing the dipping of the trucks, backlash of the train and sliding of the wheels."

THE PHILADELPHIA EXPOSITION.

The Philadelphia Commercial Museum and the Franklin Institute have planned an industrial exposition to be held in a new and appropriate building to be erected on the west bank

of the Schuylkill and within easy access of the City Hall in Philadelphia. The object is to afford means for promoting international commerce and by exhibits of products and processes of manufacture to aid manufacturers and purchasers to come together for the discussion of topics of interest in international trade. The buildings provide more than eight acres of exhibition space. Light and power may be obtained from a power plant which is included. The exhibits will embrace foreign as well as home products, and the important subject of the proper method of packing and marking goods for foreign shipments is to be illustrated by aid of models. This is a more important matter than appears at first thought, because of

NELS' SEMAPHORE GLASSES.

The adoption of the Nels yellow glass for semaphore signal purposes by the New York, New Haven & Hartford Railroad has had the effect of directing attention to necessary improvements in signal glass as to strength, durability and uniformity of color. It is very important that signal lights should have most careful attention because of their responsibility in giving indications to the runners of fast trains, and yet it is common practice to purchase commercial glass, either red or green with no specification as to shade and usually samples are not even submitted. The glass is required to be "double thickness," but when cut from large sheets which are not uniform in thickness, the strength and the color varying considerably in discs that are cut from the same sheet. Good glass costs more than poor and when the cost of renewals and the insurance against accidents are considered it will certainly pay to use the best, especially in view of the increasing speeds of trains.

We have just received a set of standard colors from Messrs. Redding, Baird & Co., of Boston, the manufacturers of the yellow glass we noted last month, and find them admirable in every way, so far as inspection can show their qualities. The glass is $\frac{1}{4}$ -in. thick and exceedingly strong. The studied irregularity of the surface is like that of the yellow and the reasons for this and also for the small lens surface cut in the center of each disc were fully stated on page 125 of our April issue.

The red disc is most interesting because instead of being coated on one side only with red, this glass has the red incorporated throughout the disc and it cannot peel or flake off. This feature is important in any system of colors but is most important on roads using white for an all-clear signal.

THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.

This association, which, by the way, has too long a name, was formed at Buffalo March 30, and the following officers were elected: President, Mr. John F. Wallace, Illinois Central; Vice-Presidents, Mr. P. A. Peterson, Canadian Pacific; W. G. Curtis, Southern Pacific; Treasurer, Mr. W. S. Dawley, Chicago & Eastern Illinois; Secretary, L. C. Fitch, Baltimore & Ohio South Western. The directors are prominent engineers and maintenance of way officers. It is an organization of officers engaged in the location, construction and maintenance of railways. The objects are to treat maintenance of way subjects by papers and discussions and to maintain a library. It is stated that a large amount of committee work will be done and that important subjects are to be placed in the hands of standing committees. The headquarters will be in Chicago and the annual meetings will be held in any city that shall be decided upon by vote. The association will probably be a most useful one. Its field is very important and its affairs are in the hands of very able men.

BOOKS AND PAMPHLETS.

Machine Design. By Forrest R. Jones, Professor of Machine Design, University of Wisconsin. Part I., Kinematics of Machinery. Price \$1.50. Part II., Form Strength and Proportions of Parts. Price \$3.00. John Wiley & Sons, New York, 1899.

Part I. has 165 pages, 8vo., and treats of the principles of mechanical motions, clearly and concisely. This is a good book for the use of students in taking up the fundamental motions of machine design. It is free from useless forms and seems to be very well written. It might have been put into the form of a preliminary part of the second volume with good effect.

Part II. is an exceedingly useful book. It differs from all other books on the subject in the large amount of very valuable data from large engineering firms, such as Fraser & Chalmers, The Baldwin Locomotive Works, E. P. Allis & Co., Lane & Bodley, and other equally well-known concerns. The design of important parts of engineering structures is presented in the abstract by examples and in mathematics. In addition to this the practice of these experienced firms is quoted where it is possible. It is one thing to be told how to design collar thrust bearings and quite another to be able to obtain a table showing the practice of the Newport News Shipbuilding Co., and to have the practice of the Marine Iron Works Co., of Chicago, in smaller work. The design of engine fly-wheels is made clear and comprehensive by abstract treatment, followed by such an example as the 25-ft. fly-wheel, weighing 160,000 lbs., made for the power station of the West Chicago Street Railway Co. by Messrs. Fraser & Chalmers, and a number of other important examples. No amount of discussion of the principles of the design of locomotive boiler seams could be as effective as the practice of the Baldwin Locomotive Works, illustrated in large, clear engravings. The book is admirable and the author shows that he appreciates the troubles of machine designers and he has probably learned, from experience, the value of good precedent as a support to calculations and theoretical designing. For example, one who has occasion to provide for forced fits will be very thankful to have several pages of data from the practice of successful machinery builders. The work is very well done, but it is not complete. The author should include other subjects, and probably will do so in future editions. If he does he will not only find a ready sale for the book, but will earn the thanks of many engineers and draftsmen. It can not be fairly compared with Unwin, but those who have the book under review will probably use Unwin less than before, and they will have the benefit of a great deal of information that has not been published, and this is of a character that has been guarded with scrupulous care by the manufacturers of machinery. The subjects considered are as follows: bearings and lubrication; spur and friction gears; belts and ropes for power transmission; screws for power transmission; screw gearing; screw fastenings; machine keys, pins, forced and shrinkage fits; axles, shafting and couplings; friction couplings and brakes; fly-wheels and pulleys; cylinders,

tubing, pipes and pipe couplings; riveted joints; frames of punching, shearing and riveting machines, and selection of materials.

Boilers and Furnaces Considered in their Relation to Steam Engineering. By William M. Barr, Member A. S. M. E.; 405 pages. Illustrated. Philadelphia: 1899. J. B. Lippincott Co. Price \$3.00.

This is a good book on stationary boiler design. It contains a great many examples of safe practice, and while it does not abound in startling, new ideas, it is full of carefully considered and well studied matter that boiler designers and users will find needful. It is not all original, as the author has reprinted extracts of papers and discussions and has included the conclusions derived from several reports that have been printed previously, but nothing has been copied that is available to the general reader who does not have access to the originals. As an illustration, comparatively few have the reports of the work done on the government testing machine at the Watertown Arsenal, and yet these contain probably the most valuable records of tests on riveted joints that have ever been printed. The author presents these and several extracts from the proceedings of the American Society of Mechanical Engineers; for example, Mr. Cole's paper giving the results of his very elaborate tests on stay bolts, and Whitham's conclusions on the subject of retarders in the tubes of steam boilers. The book was written because of the necessity for revising the author's previous work on "High Pressure Steam Boilers," which appeared 20 years ago. It is a book of construction detail, showing by a large number of engravings the latest and best practice in design. It includes more reliable and valuable data on riveted joints than we have seen anywhere, and for this alone the book will have a large sale. Its greatest value will be to the younger men in the profession, and especially to students. The book is thorough and it does not attempt to cover the entire subject of boilers. Marine and locomotive practice are to be treated in separate volumes, to appear later. It is thoughtfully and carefully written. The letter press and binding are excellent and the engravings are good. The book is the first of a steam engineering series by this author, each volume of which will be complete in itself.

Annual Report of the Board of Regents of the Smithsonian Institution. Government Printing Office, Washington, 1898.

This volume contains the usual reports of the progress made by the institution and its condition at the end of June, 1897. Following this 564 pages are given to appendixes which are unusually interesting in this report. They nearly all relate to scientific progress during 1897. Among them are: "Story of Experiments in Mechanical Flight," by S. P. Langley. The "Discovery of New Elements Within the Past 25 Years," by Clemens Winkler; "Letters from the Andree Party," "Life History Studies of Animals," by L. C. Miall; "Recent Research in Egypt," and the "Building of the Congressional Library in Washington."

Intercontinental Railway Commission Report.

This is a monumental public document which for completeness of plan and execution is admirable. It is a record, in seven large octavo volumes, including maps, of the work of this commission in their labors in surveying and exploring for the suggested Intercontinental Railway through Central and South America. This idea had its origin in 1821, when Simon Bolivar proposed a close connection between the Spanish colonies of Central and South America. After a number of congresses were held to consider the subject, a bill was proposed in the Congress of the United States in 1880 for the purpose of encouraging closer commercial relations between the United States, Mexico, the States of Central and South America. A law was passed in 1884 authorizing a traveling commission. Afterward delegates from 18 governments met and recommended the construction of an intercontinental railway, which resulted in the appointment of this commission, whose report we now have before us. Lieutenant R. M. G. Brown, U. S. N., was appointed executive officer, and Captain E. Z. Steever, U. S. A., secretary. Three corps of engineers were put into the field, one under the command of Capt. Steever, another under Mr. William F. Shunk, and the third under Mr. J. Imbrie Miller.

The results of their labors are recorded in the volumes published by the expense of the Government. Volume I. contains the report of Corps No. 1, relating to Guatemala, Salvador, Honduras, Nicaragua and part of Costa Rica; in Volume II. that of Corps No. 2, relating to Costa Rica, Colombia and part of Ecuador; Volume III., Corps No. 3, referring to Ecuador and Peru. Each report is supplemented by a separate volume of maps. The entire work is well planned and executed in every particular and engineers who are fortunate enough to secure copies of the report will find it a most instructive and valuable record which is a credit to the United States Government. The office of the Secretary, Captain E. Z. Steever, is 1317 F. street, N. W., Washington, D. C.

Massachusetts Institute of Technology. Annual Report of the President and Treasurer, 1898.

This report shows this school to be in a most satisfactory condition in every way.

Massachusetts Institute of Technology. Annual Catalogue, 1898-1899.

This catalogue gives the usual statements of courses of instruction and a register of the alumni.

"No. 25,000" is the title of a pamphlet received from the Ingersoll-Sergeant Drill Company, announcing the fact that the serial numbers given to the rock drills made by them have reached this large number. The pamphlet gives an idea, in graphic terms, of what this large output means. The firm is now able to turn out 1,800 of these machines per year.

Compound Locomotives.—The latest pamphlet, No. 11, of the series on locomotives regularly issued by the Baldwin Locomotive Works, contains a reprint of the proceedings of the St. Louis Railway Club, including the paper read by Prof. R. H. Smart, giving a record of the data taken by him from the Vaucelain compound model locomotive at Purdue University. It also contains Mr. Vaucelain's discussion of the paper before the same organization. Together, they constitute a valuable addition to the literature of the compound locomotive, with particular reference to high speeds, and many railroad officers will be glad to be able to preserve it in this convenient form.

The W. Dewees Wood Company, manufacturers of the well known patent planished sheet iron, smooth black sheet iron, and patent planished locomotive jacket iron, are soon to issue a handsome pamphlet illustrating and describing, with considerable attention to detail, their works and methods of manufacture. From the initial process of cutting wood for charcoal-pits to the final delivery of the finished product in the warehouses of the company, the various processes will be illustrated and described in sequence. The Chasmar-Winchell Press, of New York, are to print it, and their instructions are to spare no effort to turn out as handsome a work as is possible.

Shaw Electric Traveling Cranes is the title of a handsome book in boards recently issued by Messrs. Manning, Maxwell & Moore, 85 Liberty street, New York, in response to many requests for catalogues of cranes. The book illustrates thirty-five electric cranes built by the Shaw Electric Crane Co., Muskegon, Michigan, as installed in the largest and best known manufacturing establishments in the United States, as well as the Government gun and navy yard shops. The selection of subjects was made with reference to showing different principles of construction and operation and, incidentally, the book constitutes a study of modern improved shop arrangements in which it is made prominent that these large and successful manufacturing concerns consider it very important to provide the best facilities for handling heavy loads quickly, cheaply and conveniently. The catalogue contains instructions for ordering, a list of types and capacities, a diagram stating the information desired by the manufacturers in making estimates. Under the caption "General Remarks," an excellent discussion of the construction and operating mechanism of electric cranes is given. The book is one that should be in the library of every engineer and works manager, for it is the best book on modern cranes that we have seen. It should be consulted by the mechanical railroad officers, whether they are contemplating new shops or improvements in old ones. The engravings are good and the binding excellent.

"Four Track Series" No. 22. The New York Central & Hudson River Railroad, Mr. Geo. H. Daniels, General Passenger Agent, has issued a very attractive illustrated folder entitled "Saratoga, the Beautiful," which is numbered 22 in the "Four Track Series." It is a fitting addition to the fine collection of books gotten up by Mr. Daniels to give information concerning this railroad and is well worth sending for. Copies may be obtained by sending two 2-cent stamps to Mr. Daniels, Grand Central Station, New York. One of the features of the book is the description and illustration of the new train to be placed in service early this season by the New York Central, to be styled the "Saratoga Limited" which, it is said, will make as fast time as the "Empire State Express," reducing the time between New York and Saratoga from five hours to three and a half hours.

The Ingersoll-Sergeant Drill Co., 26 Cortlandt street, New York, have issued a little pamphlet containing a small engraving of each of its many types of air compressors, accompanied by brief descriptions of each. The many manufacturing interests with which compressed air is connected is presented in a striking way by a glance at this pamphlet.

EQUIPMENT AND MANUFACTURING NOTES.

The J. S. Toppan Co. have moved from the Temple Court Building Chicago, to the Great Northern Building in that city.

The headquarters of the National Electric Car Lighting Company in New York have been removed from 30 Broad street to 71 Broadway.

The Babcock & Wilcox Co. have received orders during the first three months of this year for as many boilers as they sold during the entire year 1895, and nearly as many as were sold during 1896.

The Leach locomotive sander was specified for attachment to the Schenectady compound consolidation, and also the mogul locomotives for the Southern Pacific, which are illustrated elsewhere in this issue.

The Chicago Grain Door has been ordered for the 500 cars which are now building by the Chicago, Milwaukee & St. Paul at its West Milwaukee shops, and also for 1,000 cars for the Chesapeake & Ohio, to be built at Pullman.

The Chinese Eastern Railway, which is a continuation of the Trans-Siberian line, has ordered 80,000 tons of steel rails of the Maryland Steel Works. The order is to be executed at Sparrows Point. It is expected that the first installment will be shipped early in May and that monthly shipments will follow.

A dozen or more of the 45 consolidation compound freight locomotives, recently ordered for use on the southwestern division of the Baltimore & Ohio Railroad, are in service, and are giving entire satisfaction. On the Mississippi division, they have increased the train haul 40% over the old line. When the grade reductions are completed the improvement will be even more noticeable. The compound ten-wheel passenger engines have developed unexpected pulling power and unusual speed.

The Chicago Pneumatic Tool Co. reports for the month of March the largest amount of business ever done in a similar time in its history. These orders are from many different concerns, including railroads, ship builders, manufacturing concerns and foundries. In foundry work they find extensive use in chipping castings and in drilling. The record for March, 1899 is considerably more than double that of the corresponding month of last year and the business for April is more than for March. April 11 orders were received for 158 pneumatic tools, including compressors, drills, hammers, riveters and other tools. They are going to people who are extending the use of compressed air and this increase in trade is a fair index of the condition of the business of the country.

The "Simplex" bolsters, which are illustrated in this issue as applied to the new cars for the Lake Shore & Michigan Southern and the Pittsburgh & Lake Erie Railways, are making rapid progress. Over 30,000 have been placed in service since the beginning of the current year. They have been specified recently for 200 box cars for the Missouri, Kansas & Texas, 2,000 coal cars of 80,000 pounds capacity for the Hocking Valley, 800 coal cars of like capacity for the Chesapeake & Ohio, and for the 500 coal cars for the Lake Shore.

Some time ago the Pullman Company, as an experimental measure, introduced "Ordinary" sleeping car service on the Baltimore & Ohio Railroad between Baltimore and Newark, and Pittsburg and Chicago. The results to the railroad company were very gratifying, but subsequently it was ascertained that the Pullman Company was not in position to furnish this class of equipment to all roads operating Pullman cars east of Chicago and St. Louis, and to allay any friction that might result from this inequality of service, the Pullman Company requested the Baltimore & Ohio Railroad to resume the standard cars previously in service, which has been done commencing April 10.

An Otto gas engine, operated by gasoline and furnishing about 20 horse-power, has been installed on the Hackensack drawbridge of the Erie Railroad. The change was made with a view of replacing the old steam engine with a more economical power which would avoid the inconvenience of handling coal and ashes on the busy main line bridge. The gasoline engine is started about a half minute before it is necessary to open the draw, and as it is stopped again immediately after closing the bridge, the fuel cost is very low, and there are no "stand by" losses. A steam engine, however, requires full working steam pressure the year around, and 24 hours every day. Drawbridge operation is almost an ideal field for the internal combustion engine. This plant was installed by the Otto Gas Engine Works of Philadelphia.

The Chicago Pneumatic Tool Company announces valuable acquisitions to their working force in securing the services of Messrs. J. W. Pressinger and J. M. Towle. Mr. Pressinger is well known to users of compressed air through his long connection with the Clayton Compressor Works, and he now leaves them to become connected with the New York office. Mr. Towle, who will open an office for this company in Boston, has been for the past ten or twelve years engaged in the manufacture and sale of pneumatic tools, and is an expert in that line, and is well known throughout the East, where his work had principally been done. With this arrangement the Chicago Pneumatic Tool Company will have offices in Chicago, Buffalo, New York, Boston, Pittsburg, St. Louis and San Francisco.

A pertinent point bearing on the "first cost" idea of jackets for locomotives is the fact that there is no locomotive builder in this country who does not, in the absence of instructions to the contrary, place Wood's patent planished iron on every locomotive built. It has never been demonstrated to the satisfaction of any real student that the first cost of painted jackets, leaving aside the question of constant renewal and the matter of appearance, is lower than that of patent planished iron. One would hardly lack temerity, were he to assert that locomotive builders are inferior to any railroad men as figures on the question of relative cost. And the fact that there seems to be no question in the minds of locomotive builders carries its own conclusions.

The best method of protecting metal and wood surfaces by paints is a problem which is occupying a great deal of attention. The best means for determining the value of protective coverings is to examine the records obtained in service, and we have just received a communication from the Shearer-Peters Paint Co., of Cincinnati, Ohio, which contains so many favorable reports that we have reproduced it in part, as follows:

Mr. W. H. Lewis, Superintendent of Motive Power of the Norfolk & Western Ry., says: "Up to the time of testing your paint the most durable covering we had tried on our locomotive

front ends lasted only one week, really only about five days. At this time those painted with your paint have been run for five weeks, and are still all right. This result warrants us in placing an order for a considerable quantity of your goods." Later, Mr. Lewis writes: "The Shearer-Peters paint is the best we have ever used. We have adopted it as our standard for locomotive front ends, etc."

The Collins Park & Belt Railway of Atlanta, Ga., used this paint on the roof of their power house over two years ago. The roof was in an awful condition and it was thought necessary to put a new roof on at once. Mr. M. B. Carlton, General Manager of the road, writes under date of Jan. 20, 1899: "I had no idea Mr. Shearer could do the roof any good, but he certainly did, and during all this time the roof has not leaked."

"After thoroughly testing the Shearer-Peters paint on service pipe, retorts, holders, boiler fronts, etc., I am convinced that it is just the thing gas men have long sought for. It is far superior to any other paint I have ever used, and I believe it will sustain every claim the Shearer-Peters Company make for it. Respectfully, H. H. White, Supt. Portsmouth, Va., Gas Co."

Wm. H. Wood, of Media, Pa., hydraulic engineer and builder of special machinery, reports a large number of equipments which he has completed. He has very recently put in a complete hydraulic riveting plant for Thomas Kingsford, Oswego, N. Y., consisting of a 9 foot gap riveter to put a pressure on the rivets up to 75 tons; a 15 ton overhead crane, 10 inch by 12 foot accumulator, with hydraulic pump, complete. He has also furnished the Aultman & Taylor Machinery Co., of Mansfield, O., with his new patent cylinders for their hydraulic riveting machines. He has put in a hydraulic riveting plant for the McIlvain & Spiegel Boiler & Tank Co., of Cincinnati, O., consisting of 9 foot riveter, 8 inch by 10 foot accumulator, and 8 ton crane, with hydraulic pump, complete. He has furnished this same company a 15 ton hand traveling crane having a span of 46 feet 9 inches, which can be operated by one man controlling the full load; a similar plant for Borger Bros. & Co., of Columbus, O., and one for the Enterprise Boiler Co., of Youngstown, O.; also a 600 ton hydraulic press for the Fox Pressed Steel Equipment Co., of Joliet, Ill., and a 1,100 lbs. single standard steam hammer. He has also furnished the Du Bois Iron Works, of Du Bois, Pa., a hydraulic upsetting and forming machine; also hydraulic pump, accumulator, etc., all complete, as well as a hydraulic punch for punching 17 holes at one time, the outside holes to be punched 10 feet apart. He has supplied the same works with a 1,100 lbs. single standard steam hammer, and a 800 lbs. steam hammer of the same type for the Washington Navy Yard, Puget Sound, Washington. One complete hydraulic riveting plant for Orr & Sem-bower, of Reading, Pa., 9 feet 1 inch gap riveter, 8 ton crane, 8 inch by 10 foot accumulator and pump complete. Also a hydraulic pump for the Richmond Locomotive Works, of Richmond, Va., besides overhauling the entire hydraulic plant. He has furnished a 5 ton and a 10 ton hand traveling crane, 25 feet 6 inch span, for the Burlee Dry Dock Company, of Staten Island. He has shipped a 10 inch by 6 feet accumulator to the Buffalo City Gas Light Co., of Buffalo, N. Y., and two hydraulic riveting plants to Honolulu, the first of this class of machinery that has gone to the Hawaiian Islands, consisting of a 9 foot hydraulic riveting plant and a 6 foot hydraulic riveting plant, with overhead cranes, pumps and accumulators complete; also an air compressing and caulking plant. He has shipped an air compressing and caulking plant to the Kilby Manufacturing Co., of Cleveland, O., and a hydraulic flanging press to the Riverside Boiler Works, of Cambridgeport, Mass., besides other machinery and pumps to other parties, and is about to ship a complete hydraulic riveting plant to Canada, upon which a heavy tariff duty will have to be paid. This entire list speaks well for Mr. Wood's reputation for building satisfactory machinery.

POSITION WANTED.

An A1 upholsterer wants permanent employment. Knows every detail of car upholstery; 12 years' experience; parlor, sleeping, dining car and day coaches; 37 years of age; temperate; best of reference. Address "Steady," care "American Engineer."

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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STANDARD CONSOLIDATION FREIGHT LOCOMOTIVES.

PENNSYLVANIA RAILROAD.

Classes H5 and H6.

WITH AN INSET.

No locomotives ever built in this country or abroad have been designed with more care and intelligence or with the benefit of wider experience than the heavy freight engines, Classes H5 and H6, of the Pennsylvania Railroad.

These two consolidation designs are for entirely different purposes. H5 is a special pushing engine for mountain service at Altoona, where maximum power is required for a short distance only. Fifteen of these are in service, and, as far as possible, the same details were used in H6, which is a road engine, and was not required to be as powerful. The differences are seen in the drawings and dimensions, Figs. 2 and 3 of the inset accompanying this issue. The boilers are the same except at the back ends, and the details shown in the drawings apply generally to both. The differences in appearance between the two designs are not marked, even when they are seen standing together. The general plan of each design is shown and the details presented in the drawings are nearly all of H6, and are practically the same for both.

The locomotives of both classes now in service have been built at the Juniata shops and an order for 25 of the H6 is now in hand at the Baldwin Locomotive Works. The preliminary work was so thoroughly and well done that road experience with both designs has not developed a defect or shown a single desirable change to be embodied in the ones now building. There are few locomotives built under present conditions of which this may be said. Fig. 1 is from a photograph of engine No. 1,431, one of the H5 class, which shows the general appearance of both. For such large engines they are remarkably handsome.

Of Class H6 we give the following general dimensions:

Cylinders	23½ x 28 in.
Cylinders, spread.	90 in.
Tubes, number	306
Tubes, outside diameter	2 in.
Tubes, length between sheets.	14 ft.
Firebox, inside	10 ft. x 40 in.
Heating surface tubes	2,720 sq. ft.
Heating surface firebox	197 sq. ft.
Heating surface, total	2,917 sq. ft.
Steam pressure	185 lbs.
Weight, working order	198,000 lbs.
Weight on first drivers	43,000 lbs.
Weight on second drivers	43,800 lbs.

Weight on third drivers	45,900 lbs.
Weight on fourth drivers	43,800 lbs.
Weight on truck	21,500 lbs.
Weight of tender, loaded	104,600 lbs.
Water capacity	6,000 gal.
Coal capacity	22,000 lbs.
Least internal diameter of boiler.	71 in.
Drivers, diameter	56 in.
Driving journals	9x13 in.
Engine wheel base	25 ft. 11½ in.

The weights of these engines are not given as absolutely accurate, but they are very nearly correct. The following figures were taken from H6 engine No. 321:

Weight:	
Truck wheels.	20,131 lbs.
Front driving wheels.	44,000 lbs.
Intermediate driving wheels.	40,200 lbs.
Main driving wheels.	41,450 lbs.
Rear driving wheels.	40,900 lbs.
Total	186,681 lbs.

These weights were taken with an average fire and about 2½ gauges of water in the boiler.

Boiler.

The boilers are of the Belpaire type, with curved crown and roof, and with the firebox above the frames, and with two cylindrical courses in front of the firebox. Cutting off the back head of H6 at an angle, besides lightening the back end and throwing the center of gravity farther forward, offers a more favorable arrangement of the firebox heating surface by removing the dead spaces at the upper back corners, and there is less radiation at long range while none of the available surface of the crown sheet is sacrificed. The space thus gained is used for an admirable arrangement of cab fittings. The sides of the boiler in the cab are flattened inwardly to further increase the room.

The sectional view of the boiler, Fig. 4, shows the water spaces to be 4 inches wide all around at the mud ring, and much wider above, where the necessity for long staybolts is greater. A free entrance for water is had at the throat through a space 5½ inches wide. Though there are 369 2-inch tubes, these are not placed near enough to the shell to interfere with free circulation, and a clear water space is left below them. The length of the tubes is 13 feet 7½ inches, and the diameter of the shell is 76 inches, the firebox is 10 feet long by 4 feet wide, the grate area being 33.3 square feet, and the heating surface 2,812 square feet.

The crown bolts are fitted with cup nuts, except the three bolts in each corner of the crown sheet, which are fitted with expansion joints. All of the stay bolts in the firebox, which are shown in Fig. 4 in the form of circles, are of the Nixon patent, illustrated in our issue of September, 1897, page 320. The following details of the boiler are interesting:

Fire area through tubes	6.39 sq. ft.
Grate area	33.33 sq. ft.
Heating surface tubes (external).	2,632 sq. ft.
Heating surface, firebox	180 sq. ft.
Heating surface, total	2,812 sq. ft.
Steam pressure	185 lbs.
Weight of boiler without flues	31,563 lbs.
Weight of flues	11,220 lbs.
Weight of boiler, total	42,883 lbs.

The outside sheets of the firebox are only ¾-inch thick. This is unusual and is but half the thickness of the barrel sheets. The object was to favor the staybolts as much as possible and relieve them of the effects of the stiffness of thicker sheets. The presence of the stay bolts renders it possible to reduce the thickness, which in this type of firebox does not need to be greater than that of the inside sheets. This, the form of the firebox, the Nixon stays and the best staybolt material may be expected to give good results as regards staybolt breakages. The crown sheet is ¾-inch and the flue sheets are ½-inch thick.

The mud ring corners are turned with 7-inch radii, which should help to prolong the life of the firebox. At the back end the sides of the firebox are straight and vertical, to give more room in the cab. Wash-out plugs are distributed as follows: 4 over the crown sheet, 2 in the top of the boiler, 2 (6-inch) under the boiler, 3 in the back head opening over the crown sheet and one at each corner of the legs of the firebox. The boiler has a dome, with a pressed steel top, using a straight sheet for the dome and cutting the flanged dome joint piece

also straight on top, as shown in the boiler drawing. The fire door is oval, which was the nearest possible approach to a rectangular hole, and at the same time avoiding the troublesome flanging of corners. The construction of these boilers merits an entire article. They are so carefully laid out and the work is so accurate as to be interchangeable. A back head was recently sent out from Altoona to be put into an H4 boiler at another shop, and, the work being done on formers and to templates, it was so accurate that it fitted in the boiler built some time previously.

Cylinders.

The cylinders are cast separate from the saddle, which at first sight may appear to be retrogressing, but there are several very good reasons why this is a good plan. It is not new except in application. The reasons are: (1) With this construction the shrinkage stresses, due to the form of the casting, which are so dangerous to the life of ordinary cylinders cast with the half saddle, are avoided. (2) The material for the saddle and the cylinders may be selected with reference to the work each has to do. A tough, strong iron, with comparatively low shrinkage, may be used for the saddle, and hard, close iron (which necessarily has high shrinkage) is used for the cylinders. There appears to be no difficulty to guard against the shrinkage when the castings are separated. (3) Separation simplifies the foundry problem, because it avoids the necessity for the chilling cores which were found necessary to spread the shrinkage and to prevent the formation of porous, spongy spots. (4) There is an advantage in repairs, because one cylinder may be taken down without removing the other cylinder or the saddle. (5) A two-bar frame is a necessary accompaniment of the cylinder and half saddle plan and with such an arrangement it is impossible to secure a frame connection as strong as the one before us. These reasons are probably responsible for the selection of this form of construction, and it is likely to be used in future designs in both freight and passenger locomotives on the Pennsylvania.

This arrangement of cylinders necessitates rigidity in the frame, the frame splice and the attachment of the cylinders and the saddles. The keying has been attended to with great care. The frames at the cylinders have taken the form of slab 31 inches in section and vertical flanges on the inside and outside of each frame form contacts for the cylinders and saddle. The flanges at front and back are vertical and the wedges only are planed at an angle. The wedges are cut on the planer, together and by reversing pairs they must fit correctly. It would be impossible to secure a rigid fastening by attempting to plane the frames at an angle. This plan relieves the bolts from shear. They are in tension only. The saddle casting, which would otherwise have a tendency to rock in the frames, has four bearing surfaces at each frame, the center of the portion which meets the flange of the frame being cut away so as to clear the flange and remove the possibility of the saddle rocking in case the fit should be tightest at or near the center. This is one of the relatively small details that contribute to make this design so interesting and worthy of study. The strong ribbing of the cylinder connection plate is seen in Fig. 5. In the exhaust passage care has been taken to aid the steam in the direction of the nozzle by removing the corner or pocket usually found just below the exhaust port. This is shown in Fig. 6. The saddle is also very strongly ribbed and the steam and exhaust passages are separated with air spaces between them. Drainage of water from the two steam cavities at the ends of the cylinder casting is provided by means of a pipe leading to an independent cock under the center of the cylinder and operated by the cylinder cock lever. A further movement of the lever, after the cylinder cocks are open, opens this center cock to drain the steam cavities and the cylinder cocks close after this drainage cock is closed. With a leaking throttle this valve will do good service.

Frames.

With a maximum thrust of about 68,400 pounds from each

cylinder, alternating as to direction, first on one side and then on the other, the frame problem is a difficult one and those who are having trouble with broken and loose cylinders will find these drawings valuable, because, so far, there has been no trouble of this kind. The front sections of the frames are cast steel and every precaution was taken to give rigidity and strength to the fastenings. The holding power is largely due to correctness of fit and arrangement of parts, which make this possible. The frames for both types are very nearly alike, Fig. 7. Aside from the transverse bracing afforded by the cylinders there is a cast iron bumper at the front ends of the frames, a cast steel plate across the frames at the frame splices and a strong connection brace at the back ends of the frames. The bracing against twisting stresses and those which come in taking curves on the road are provided back of the cylinders, where the tendency to wiggling actually takes place, because the designer believes that these stresses cannot be resisted by any amount of bracing placed in front of the cylinders. This is particularly applicable to the case of thin frames. The great vertical strength of this form, or slab frame, at the cylinders is also noteworthy.

The frame splice is interesting in that the keys are in compression and are relieved entirely from shearing stresses. This form has been used, as shown in the sketch, Fig. 8, which was adopted in 1892 for Class M engines. This is a very simple and important improvement. It is so easy to see its advantages, in avoiding shear and in the possibilities of securing a good fit, that one wonders that it has not been used always. The splice of Class H6 is an improvement upon the earlier form in the number of bolts used.

The expansion pads and frame clamps are shown in Fig. 9, the rear clamps and pads being similar to the front ones, which are illustrated. The parts are arranged to relieve the studs of the usual tearing stresses. The firebox tends to push against the studs, as will be easily seen in the engraving. No wear is permitted on the mud ring or the frames. The supports for the frames and also the spring seats are provided in the steel castings fitted between the upper and lower bars of the frames.

Running Gear.

Pistons.—The pistons, Fig. 10, are made with a steel centre in the form of a dished single plate to which is bolted a T shaped ring of cast iron with two packing rings. The thickness of the piston for a distance determined by an angle of 60 degrees from each side of the center at the bottom is 5 inches, for the purpose of increasing the bearing surface, while for the remaining 240 degrees the thickness is reduced to 3 3/8 inches. This increases the wearing surface where it is needed, without unduly increasing the weight of the reciprocating parts. The cylinder heads provide for the thickening of the pistons without increasing the steam clearance space. The entire surfaces of the pistons are dressed.

Piston Rods.—There is nothing unusual about the piston end of the piston rod. It is drawn up to a shoulder by a nut, but the crosshead end is exceedingly interesting, because there has been no piston rod breakage with these engines and with this design it is safe to say that there will be none unless due to bad fitting. The piston rod is shown in Fig. 11, and the cross head in Fig. 12. The rod bottoms in the cavity in the crosshead and the key does not stretch the rod (see "American Engineer," January, 1899, p. 9), but this is not all. The taper is increased to prevent too hard driving and the taper portion of the rod is cut away at the central part of its length, leaving bearing surfaces 2 3/16 inches long at each end. This is the idea followed on the cylinder and saddle joints and in the bearings of the rocker shafts. In the case of the crosshead fits it prevents the rocking of this connection, which results from swelling the piston rod by cutting the key way. A great aid in good fitting is provided in the slope of the key way in the piston rod and crosshead boss, as shown in the piston rod drawing, Fig. 11, the key slot being at right angles with one of the sides of the tapered end of the rod. The bearing against

the crosshead boss is square. The end of the rod is, of course, enlarged.

Guides and Crossheads.—The guides, Fig. 13, are of the two-bar type and of steel and 6 inches wide, with raised wearing surfaces on the sides in order that when truing up it shall not be necessary to also plane off the guide lugs. The crossheads, Fig. 12, are cast steel with block tin wearing surfaces $\frac{1}{16}$ inch thick and with 2-inch wearing surfaces on the edges of the guides. The guide shoes are secured to the crossheads by lock nutted bolts. This is a very light crosshead for such a heavy engine.

Driving Boxes.—The driving boxes, Fig. 17, are not symmetrical with reference to the journal bearing. The total length of the bearing is 13 inches, and the center of load is 1 inch outside of the center of the box. The object of this is to throw less weight upon the inner edge of the box, where the greatest wear generally occurs. The driving boxes are still more interesting in their methods of lubrication. The bearings are phosphor bronze and they have no openings at the top of the journal, but grooves $\frac{3}{8}$ inch wide, located $1\frac{1}{4}$ inches above the center of the axle and extending across the box, front and back, to within $\frac{1}{2}$ inch of the ends of the bearing. The reason for this method of introducing the oil will be found in our March, 1898, issue, page 91. The oil is fed from a cavity in the top of the driving box and the best thing about this idea is that it is successful and the journals very rarely heat. The hubs of the wheels are lubricated by grooves and the oil for this purpose is held in a separate cavity in the top of the box. The large cavity is for the journal. The wedges and shoes are oiled by four grooves at each side, receiving oil from other cavities at the front and back sides of the top of the box.

Crank Pins.—The enlarged wheel fits and ample fillets of the crank pins appear in Fig. 14.

Driving Axles.—The main axle, Fig. 16, shows the principles of construction of all the driving axles, which are of steel. The journals are large and the wheel fits are one inch larger than the journals in diameter. We desire to direct special attention to the form of the key ways in these axles. They are made with cutters, having a radius of $2\frac{3}{4}$ inches. Also, the enlarged ends of the axles where they enter the wheels are worth imitating. A very slight shoulder is left against which to bring the wheel hubs in pressing them on.

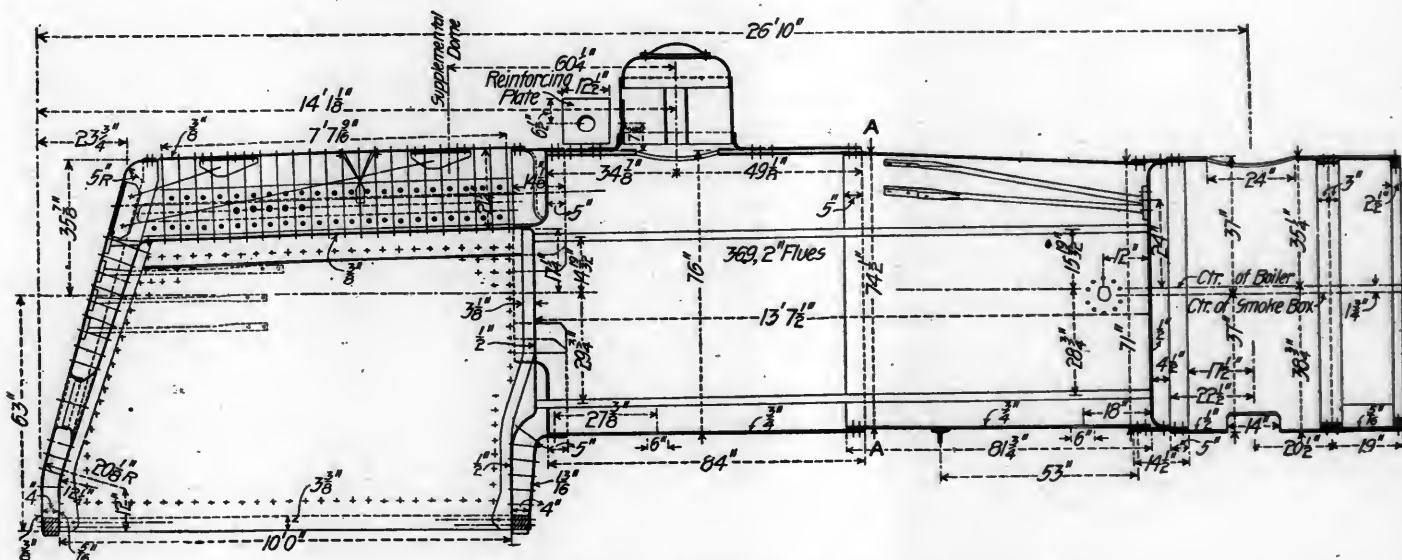
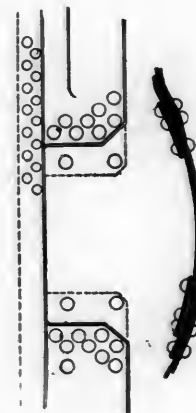
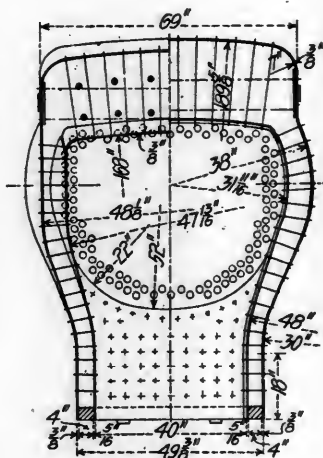
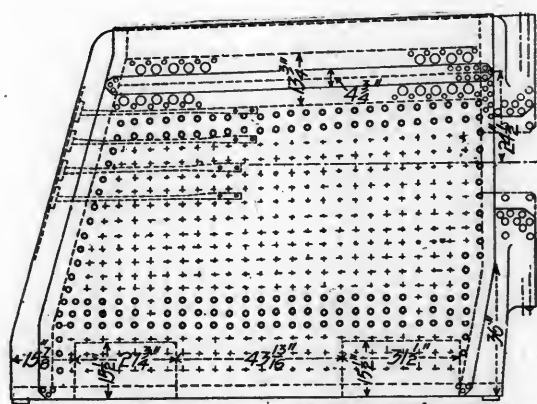
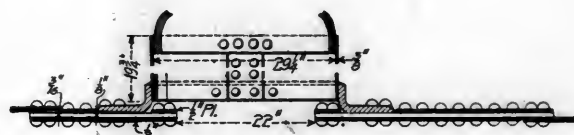
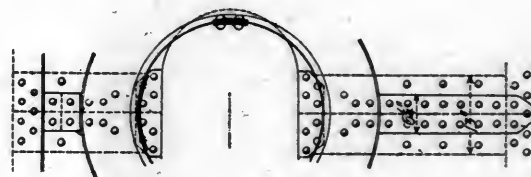
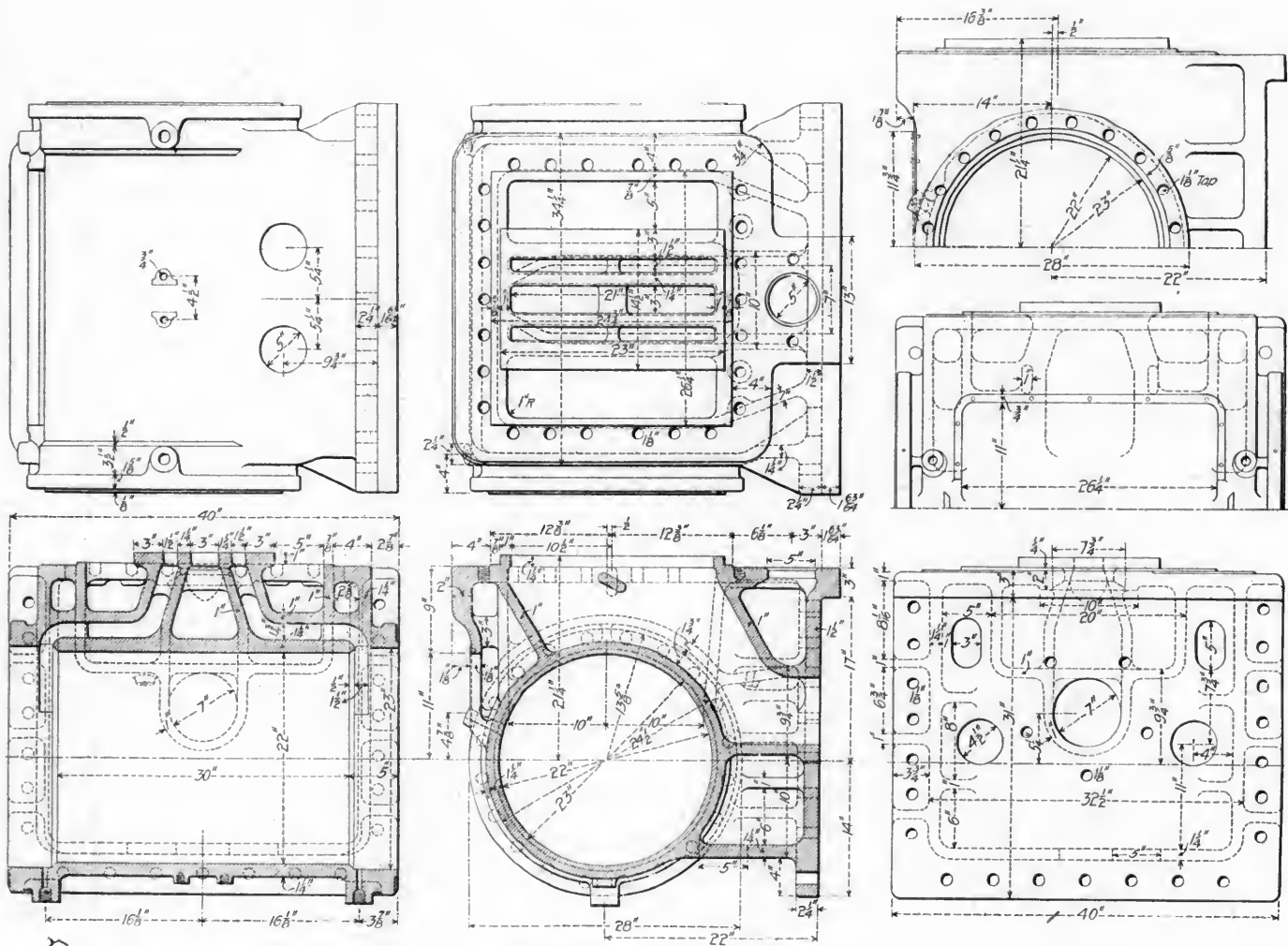
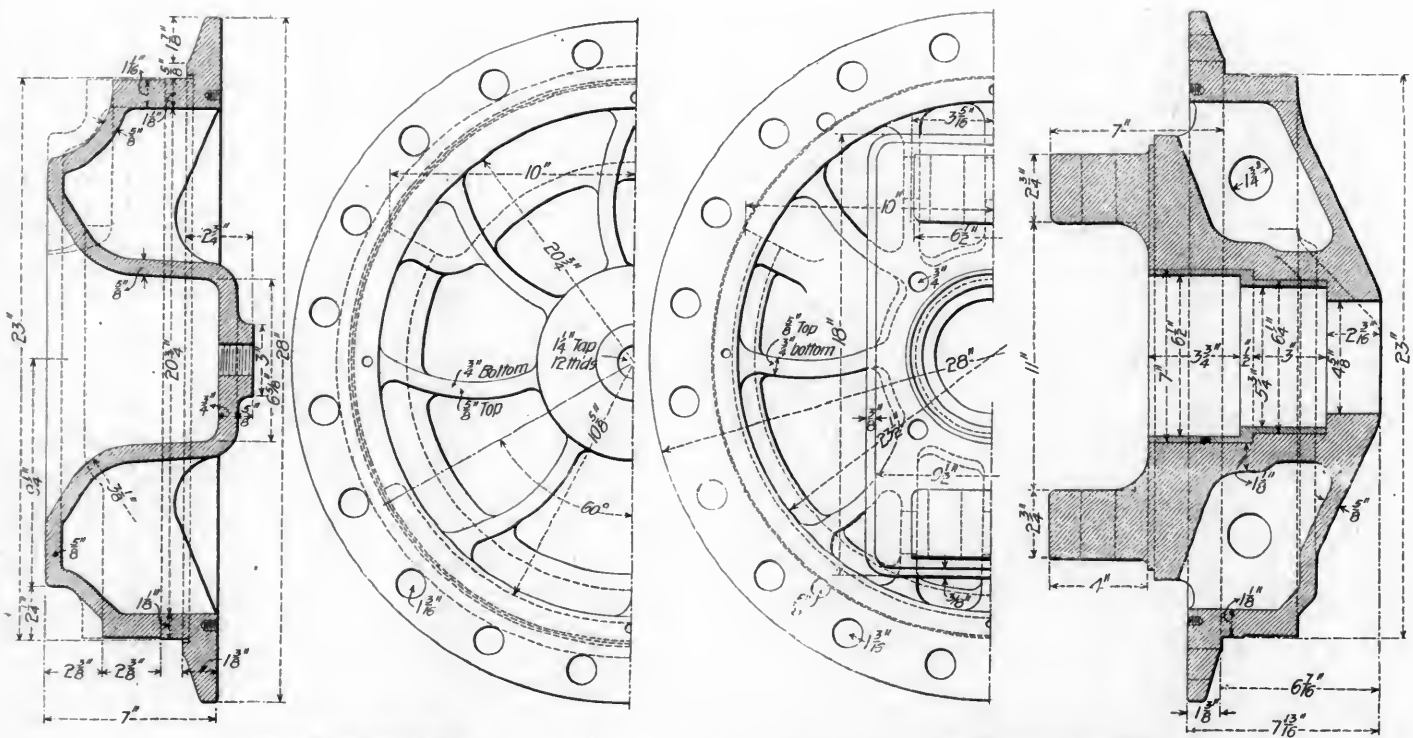


Fig. 4.—Boiler and Boiler Details.—Class H 6.



Cylinder and Cylinder Heads.



Front Cylinder Head.

Back Cylinder Head.

FIG. 6.—CYLINDER AND CYLINDER HEADS, CLASS H6.

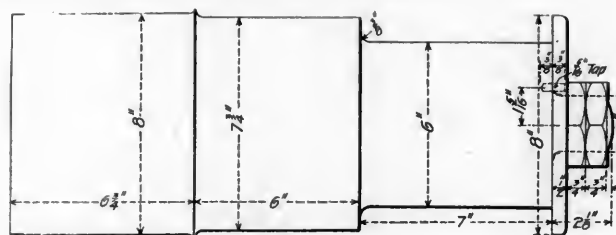
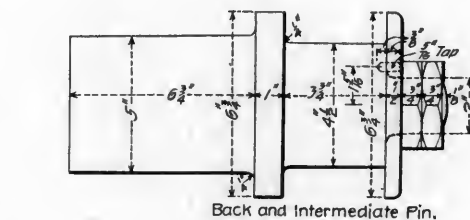
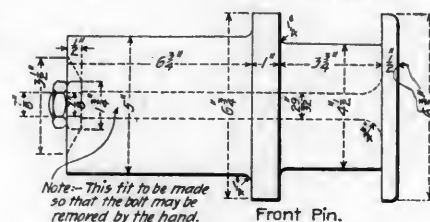


Fig. 13.—Guides and Guide Yoke.



Back and Intermediate Pin.



Front Pin.

Note:- This fit to be made so that the bolt may be removed by the hand.

Fig. 14.—Crank Pins.

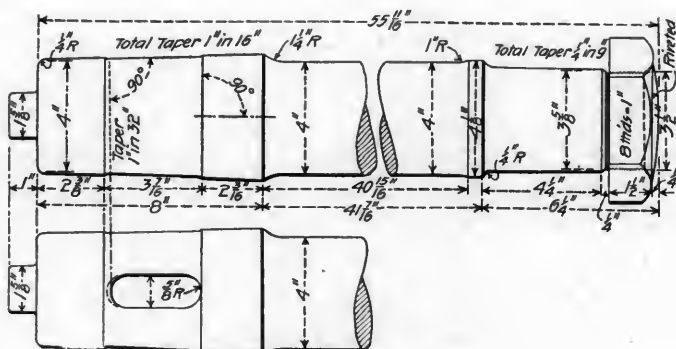


Fig. 11.—Piston Rod.

Fig. 10.—Piston.

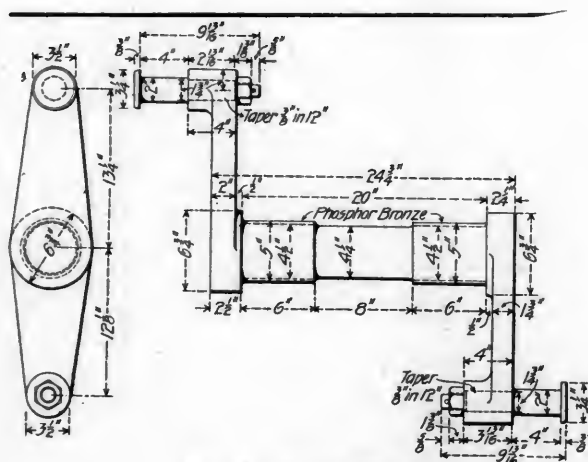


Fig. 15.—Rocker Shaft.

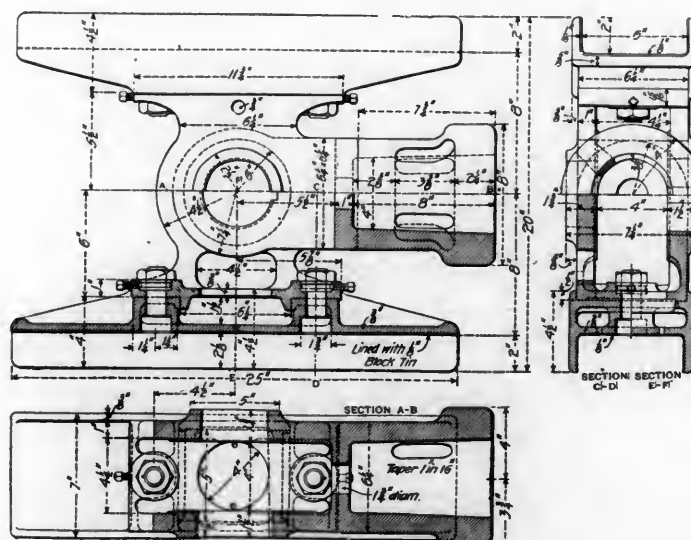


Fig. 12.—Crosshead.

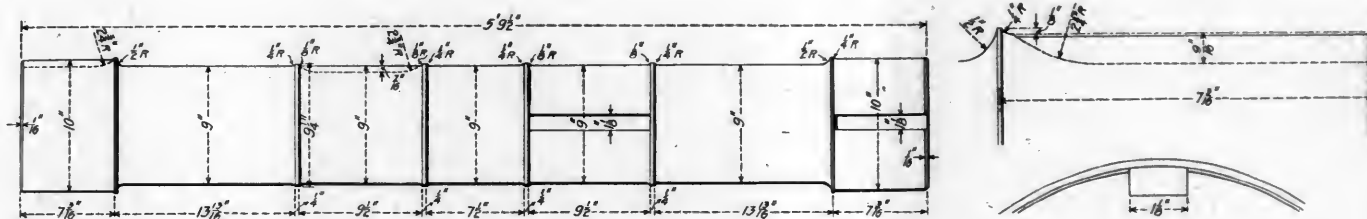


Fig. 16.—Driving Axle.

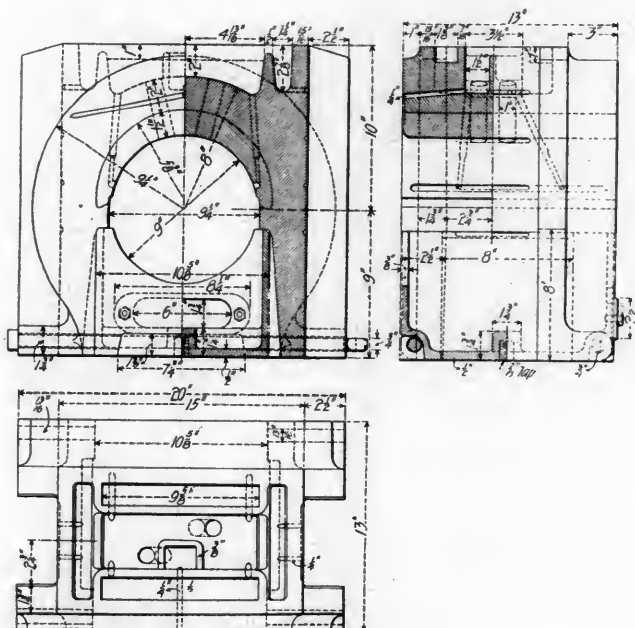


Fig. 17.—Driving Box.

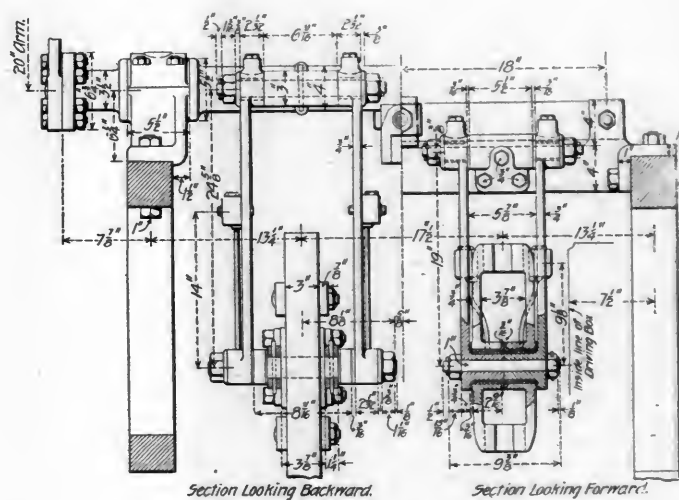


FIG. 18a.—Sections Through Valve Motion.

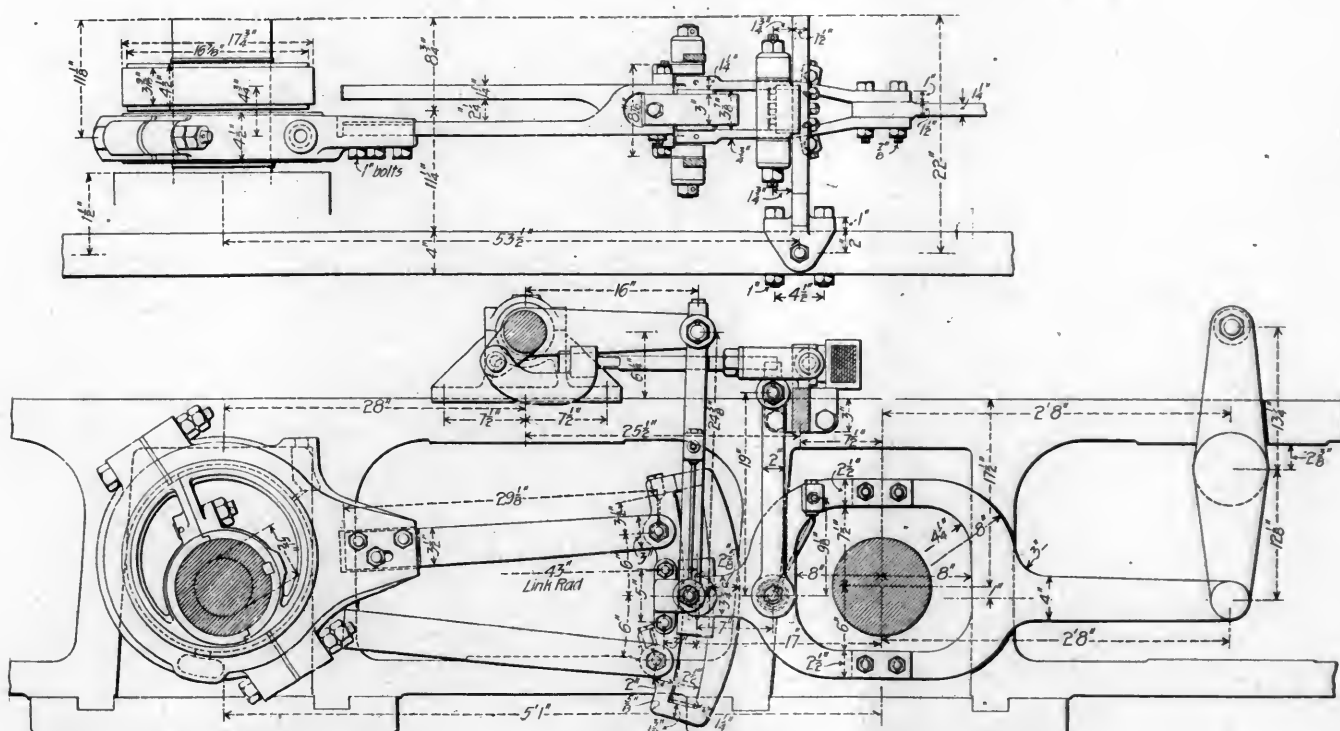


Fig. 18.—Valve Motion

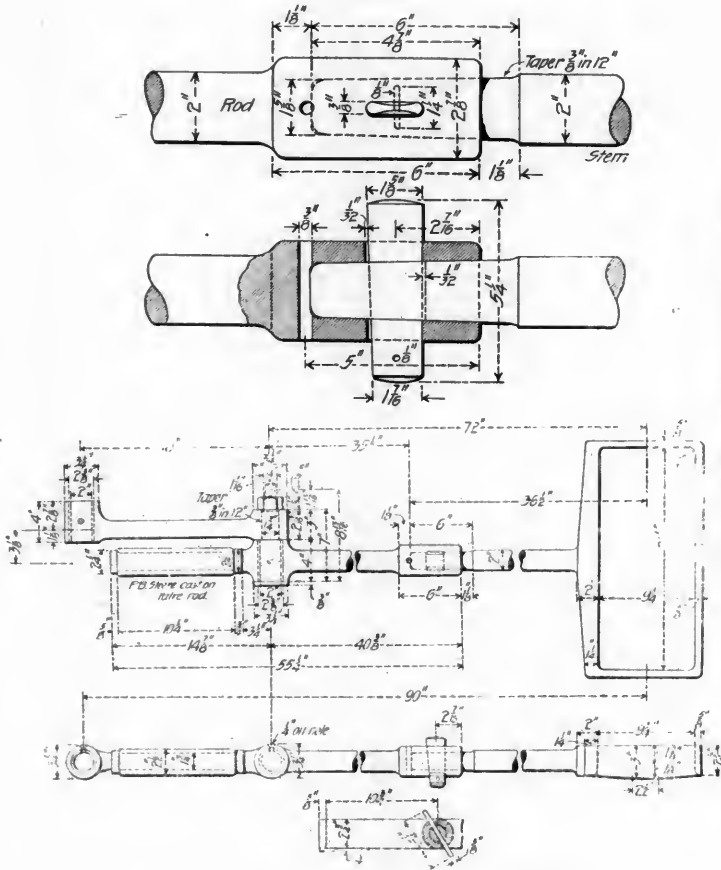


Fig. 19.--Valve Stem and Yoke.

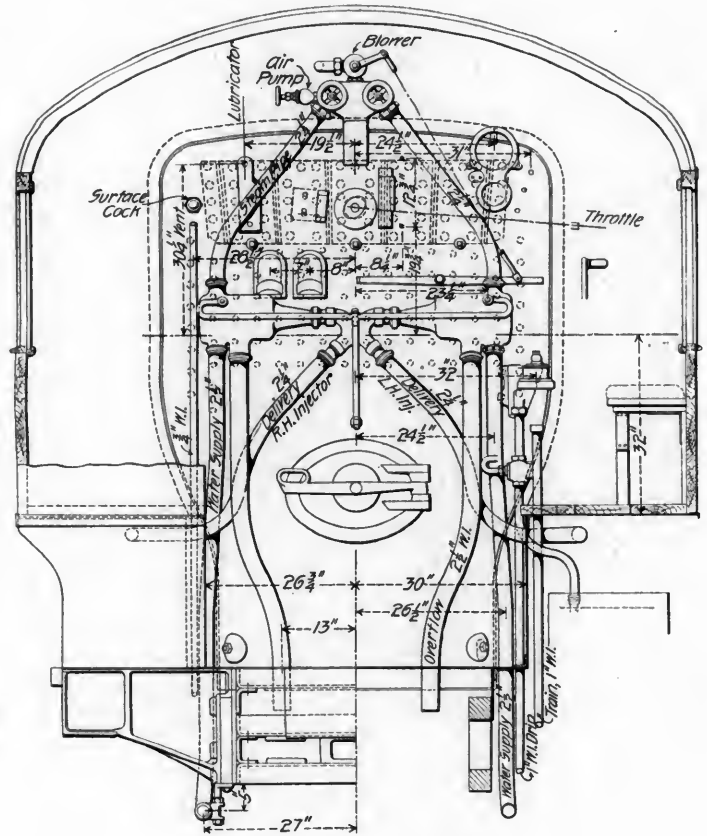


Fig. 20.—Cab Fittings.

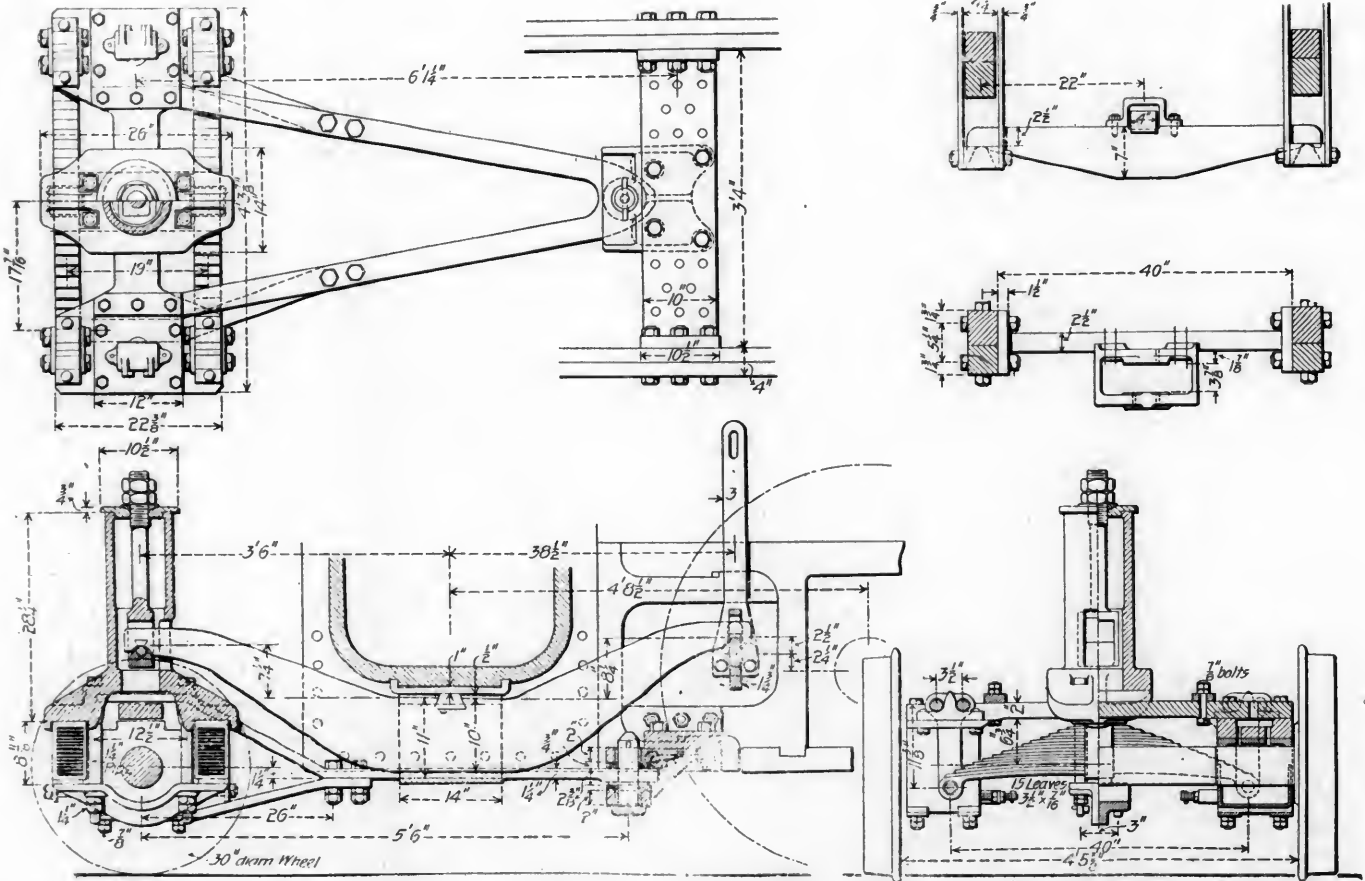


Fig. 21.—Engine Truck and Suspension.

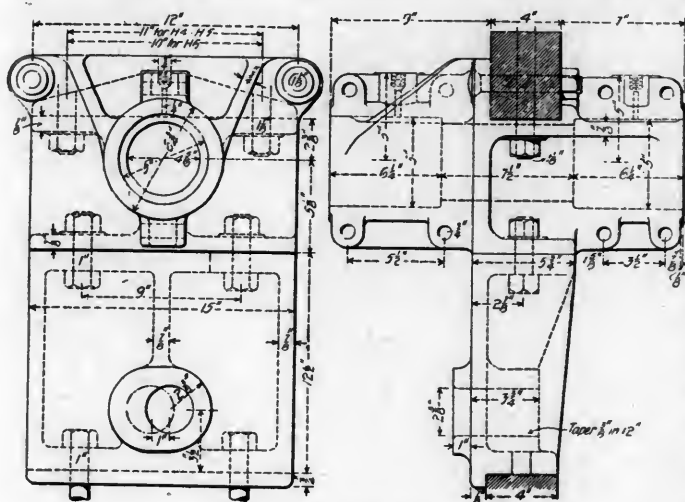


Fig. 22.—Rocker Box.

Driving Wheels.—Cast steel was used for the driving wheels, not altogether because of the saving in weight, but because the wheels are thin, being but 7 inches over the hubs, and it was decided that no chances of breakage should be taken. The front and rear driving wheels only are flanged.

Valve Motion.

The rocker box is between the first and second pairs of driving wheels, which makes it necessary for the valve gear to pass the second axle. This is done by means of a closed loop, shown in Fig. 18. From the joint at the axle the loop is integral with a $1\frac{1}{4}$ by 4-inch rod connecting to the lower rocker arm, while the connection from this joint to the link is double and is best seen in the plan views of Fig. 18. The weight of the back end of this connection is carried by double links supported on a cross piece between the frames, Fig. 18a. The attachments to the link block and to the link hangers are double and such as to transmit a straight line pull on this connecting piece, to the relief of the links and eccentrics from a twisting tendency. The drawings show the construction of this interesting detail. This valve motion is the most direct and rigid that we have seen, particularly for one which spans the driving axle. The motion is easily disconnected and by use of reamed bolt holes there is no possibility of making changes. Careful arrangements have been made for oiling. The link is strong and is reinforced by additional material at the center portion. The radius of the link is 43 inches, but the distance between centers is made 44 inches, for the purpose of reducing the lead at short cut-offs. The angle of the lifter spring arm is so taken as to decrease the lever arm as the spring compresses, which gives nearly uniform resistance.

The rocker boxes, Fig. 22, for Classes H4, H5 and H6, are alike. They are below the frames and to their lower faces filling pieces are fitted which bear on and are secured to the lower bars and form pivots for the brake hangers. The idea of preventing rocking of a bearing by the possibility of its being tightest in the middle of its length is carried out here by turning down the central portion of the rocker shaft and causing it to bear in the rocker box only for a length of 6 inches at the ends. These bearing surfaces are of phosphor bronze in the form of sleeves, $\frac{1}{4}$ inch thick, cast upon the shafts, as shown in Fig. 15. The valve stems and yokes are shown in Fig. 19, in which the knuckle joint and the phosphor bronze sleeve cast on the back end of the valve stem are shown. This sleeve has a bearing that is bolted to the guide yoke and over it are cinder shields of cast iron.

Engine Truck.

The truck is the result of wide experience, which has shown methods by which repairs may be reduced. It is illustrated in Fig. 21. The truck boxes are bolted on each end, to a straight backbone, with a palm on each end, causing the boxes to wear uniformly. The backbone carries no load and

does not cause the boxes to tilt relative to the journals. The weight is carried by initial stability links, which have obvious advantages over the common form of swinging links, and the load is transmitted to them by two springs with $15\frac{3}{4}$ by $7/16$ inch leaves. A spring keeper, under the axle, will catch the springs in case of failure of the hangers and prevent them from falling on the track. A $2\frac{1}{2}$ by 10-inch brace extending across the engine at the frame splices and with broad flanges at the ends bolted between the frames carries the pivot for the radius bar. This brace has six bolts at each end and serves also to stiffen the frames laterally. The radius bar is low and its center is $1\frac{1}{4}$ inches below the center of the axle. It has a forked attachment to the truck and the stresses and shocks are provided for in such a way as to relieve the braces from a large part of the usual shearing effects. The equalizer passes below instead of through the saddle. The boxes are accessible and the pedestal caps are not removed in order to get at the sponge boxes. These are held in place by wedges that are easily taken out. A heavy cast iron spring guard at the center of the axle is used for the purpose of catching a broken spring. This is the old Pennsylvania truck simplified and designed to make use of castings instead of expensive forgings.

Lesser Details.

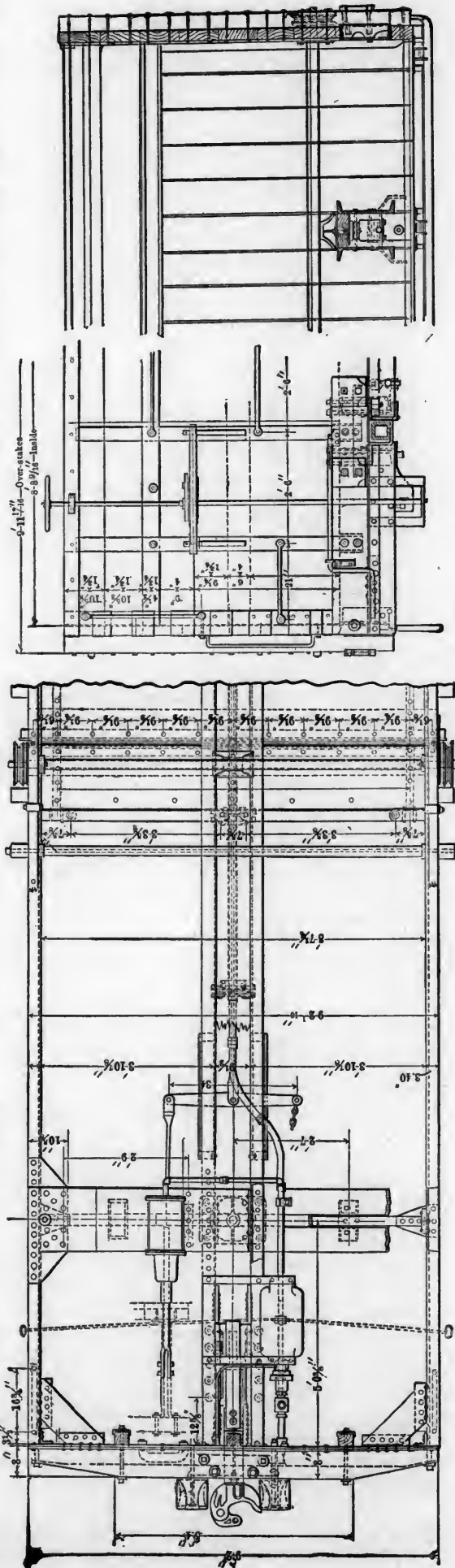
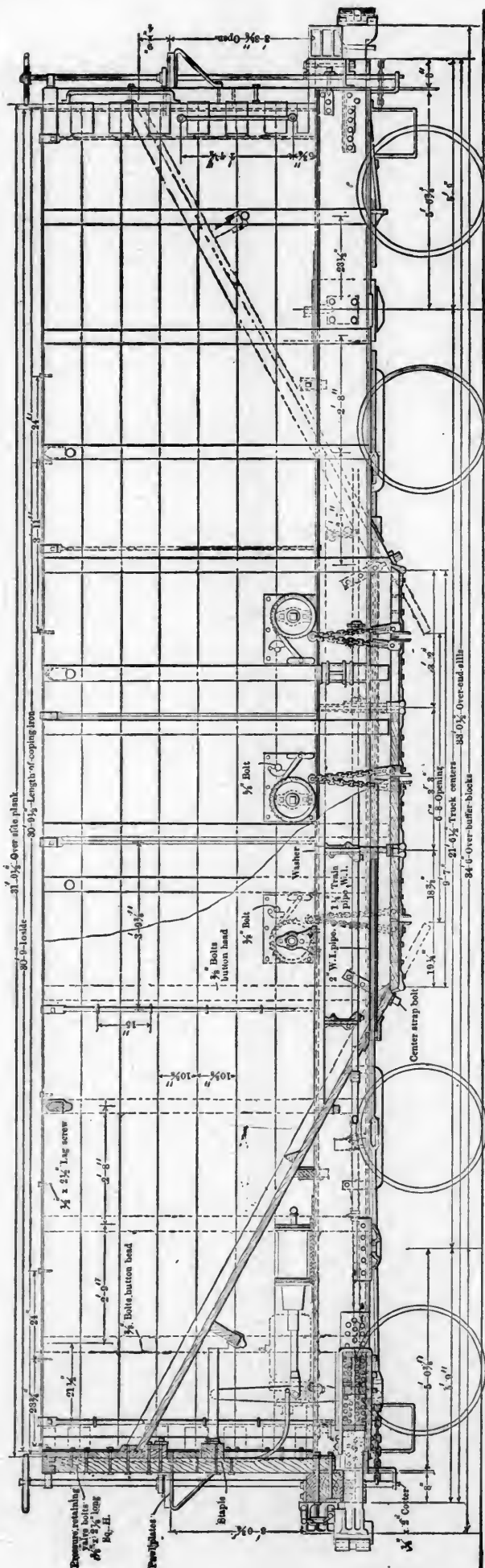
The smoke box is short, the extension proper being but 16 inches long and the whole smoke box being $66\frac{1}{2}$ inches long. The stack is of cast iron, extended inside the smoke box $28\frac{3}{4}$ inches with a bell at the bottom of the extension and the tip of the nozzle, which is single and $5\frac{1}{2}$ inches in diameter, is 20 inches below the bell. The stack and base are in one casting. The blower is in the form of a ring and the air pump exhaust is brought into the main exhaust passage in the saddle casting.

The air brake cylinders of Class H6, Fig. 3, are secured to the frame brace immediately back of the cylinders and the brake shoes are back of the wheels. One object of this was, like the sloping of the back boiler head, to throw the center of gravity ahead. There are other advantages in the horizontal pull of the air brake piston and in the relief of the driving springs from the downward thrust of the brake shoes.

The cab fittings as shown in Fig. 20 have received a great deal of attention. Figs. 1, 2 and 3 show the stop valve in the cab supply pipe just in front of the cab. This, when closed, permits of disconnecting any steamfitting in the cab, with the exception of the steam gauge. The arrangement of the cab is admirable. Even the whistle is a piece of excellent designing. It is mounted on a connecting piece, which attaches to the dome, and in it is a stop valve. The whistle operating valve is back of the whistle and cannot drop into the steam pipe when disconnected for regrinding. The lever is double with the spring between the two parts. Mr. Vogt's throttle with double fulcrum lever is fitted to these engines.

It is impossible to examine these locomotives without admiring the excellent and thorough engineering of which they are the result. They are conservatively bold. The conservatism lies in the careful investigation of the merits of each feature before it is used and the boldness is in the use of new ideas without hesitation when they are found to be satisfactory. The workmanship is in every way equal to the planning and it is altogether a privilege and a pleasure to illustrate and describe these engines.

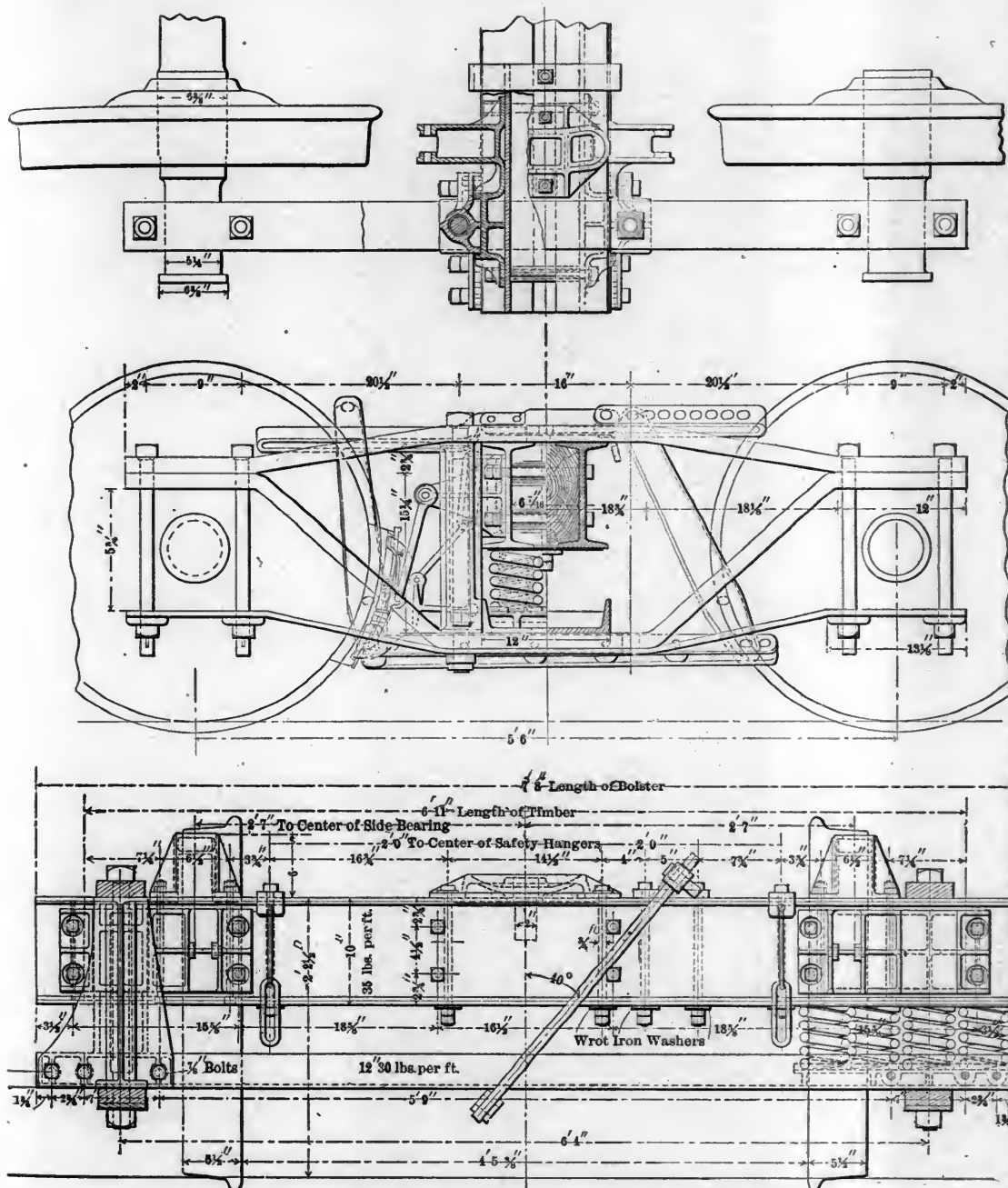
The fast mail trains on the Burlington have been making a number of fast runs. April 23 train No. 15, west bound, ran from Chicago to Burlington, 205.8 miles, in 199 minutes, or at the average rate, including stops, of 62 miles per hour. The portion of the run from Clyde to Burlington, 197.3 miles, was done in 184 minutes, or at the rate of 64.33 miles per hour, including stops. These are not record breaking runs, but they are very fast for regular service conditions. The east bound mail train on this road has been late but once since the beginning of this year, and the west bound schedule, which is four hours shorter, has been accomplished every day but four.



Steel Frame Hopper Cars, 100,000 Pounds Capacity.

Norfolk & Western Railway.

W. H. LEWIS, Superintendent of Motive Power.



Truck for 100,000 Pound Cars.—Norfolk & Western Railway.

100,000-POUND, STEEL FRAME, HOPPER CARS.

Norfolk & Western Railway.

On another page of this issue Mr. R. P. C. Sanderson, in describing the present status of the steel car, alludes to a new design by the mechanical department of the Norfolk & Western Railway which, through the courtesy of Mr. W. H. Lewis, Superintendent of Motive Power of the road, we are permitted to illustrate and describe. In connection with the description and engravings, Mr. Sanderson's arguments favoring this form of construction should be considered, and it will also be interesting to make comparisons between this design and that of the Northern Pacific Railway, illustrated in our issue of October, 1898, page 334.

Like the Northern Pacific cars, the Norfolk & Western design has wooden hoppers. The underframing of the car consists of four 15-inch 33-pound channels connected with plate transoms and end sills. Except the cross-ties belonging to the construction of the hoppers, there are no cross braces, the center sills are rigidly secured together with iron space blocks, which serve also for supporting the train pipes and brake rods. The construction of the connections and the bracing of the frames is clearly indicated in the drawings and requires no extended explanation. The draft gear brings its stresses directly upon the center sills through tandem springs, both of which are in action, whether the car is being pulled or pushed. The underframe is entirely of steel, the hoppers being of wood and the

loads are transmitted by steel bolsters to trucks of the arch bar type, the wheel base of which is 5 feet 6 inches and the construction being standard in other equipment of this road. The truck bolsters are 10-inch 35-pound I-beams with iron space blocks. The spring plank is a 12-inch 30-pound channel with a long bearing on the columns. The arch bars are 1 1/2 by 4 1/2 inches. The wheels are of cast iron 33 inches in diameter, weighing 650 pounds. The axles are 5 3/4 inches in diameter at the center with 5 1/4 by 9-inch journals. Most of the castings in the trucks are of malleable iron and the center plates are of cast steel. The M. C. B. standards for 5 by 9-inch journals are used in the journal box, the journal bearing and wedge except as to the diameter of the journal. The cars are not to be used in interchange service and in view of the fact that no standard has been established for 100,000-pound axles and journals, the designers felt free to use such proportions in the axles and journals as appeared to be justified by experience.

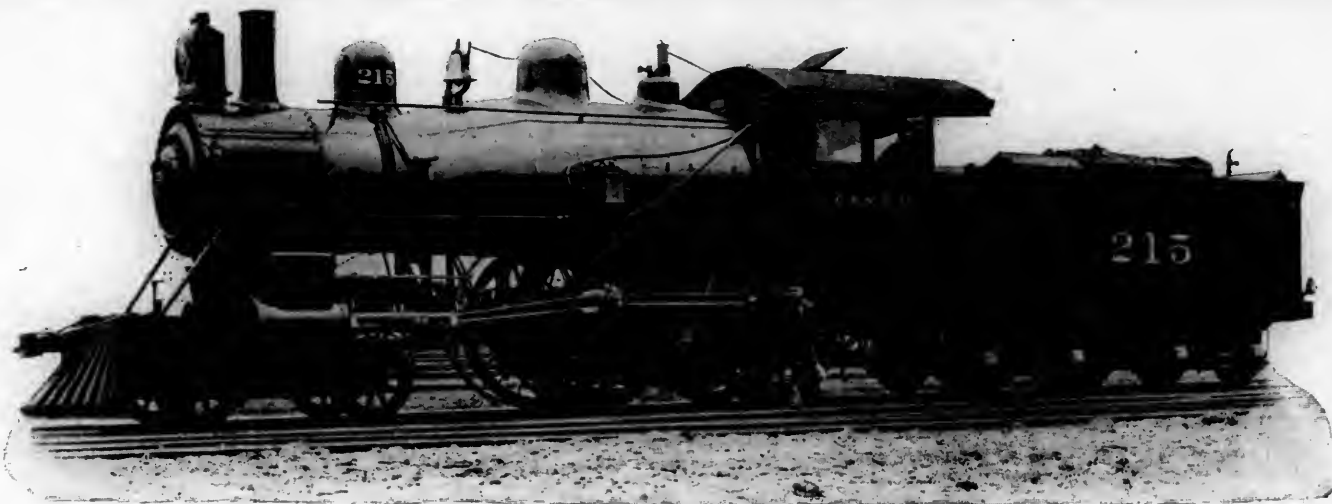
The wooden hoppers have drop bottoms of the type used by this road in other equipment, except that in this case three doors are employed, the construction of which is clearly indicated in the drawings. The chains for handling the doors have been kept upon the outside of the car for the purpose of avoiding damage while unloading the cars. They are arranged to be operated from either side and the chain sheaves are mounted on heavy shafts extending across the car, these being protected by 2 1/2-inch pipe, which also serves to tie the

sides of the hoppers together. The ties at the bottom are in the form of cross pieces, to which the doors are attached. Four one-inch rods serve as top ties and these are provided with thrust timbers protected by angle irons. The side and end boards of the hoppers are 2 3/4 inches thick, experience having demonstrated the necessity for this precaution. The bottoms of the hoppers are of 1 3/4-inch oak. The sides are secured by stakes carefully proportioned to prevent bulging and thoroughly secured to the sills and sides of the hoppers.

The design has been very carefully studied and a thorough examination of it conveys the impression of simple strong construction intended for continuous severe service under exacting traffic conditions. The specially noteworthy feature aside from the form and arrangement of the underframe is the employment of commercial shapes of structural steel and the absence of special or unusual sizes of material, the purpose being to facilitate repairs from stocks that are ordinarily available.

The weight of the car empty will be about 38,000 pounds, but the exact weight is not yet known. A recent test with a sample car loaded with coal showed a deflection of less than 1/4 inch on all four of the sills, which indicates that the fibre stresses in these members have been kept below the calculated amount, which was 12,000 pounds per square inch. Orders have been placed for material for building 1,000 of these cars, the work to be done at the Roanoke shops of the road.

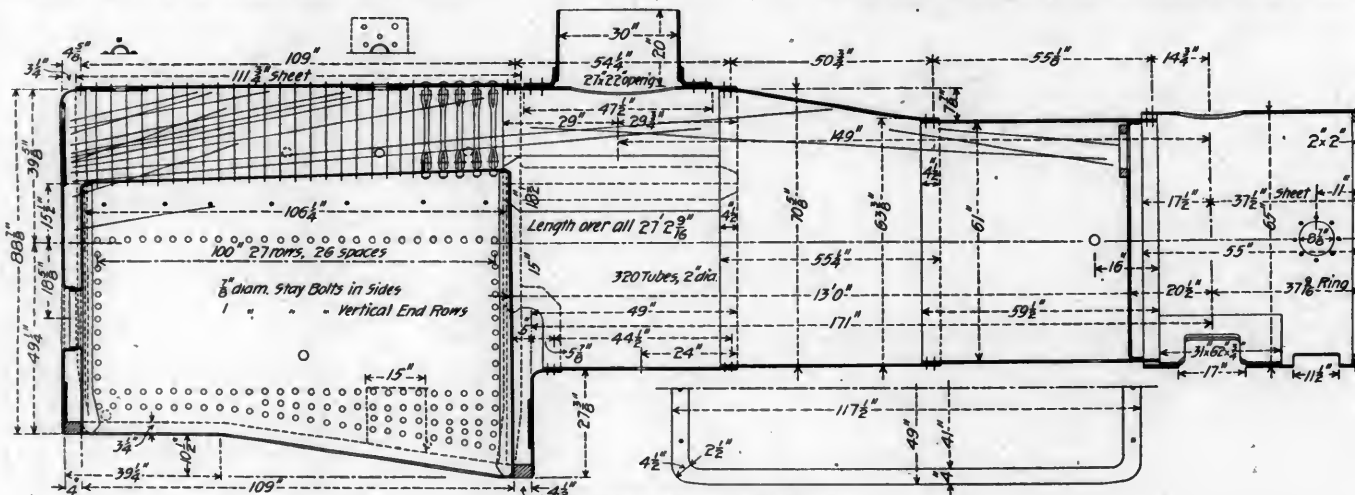
Mr. Sanderson's article will be found on page 190.



Fast Mail Locomotives—Chicago & Northwestern Railway.

ROBERT QUAYLE, *Superintendent Motive Power.*

W. H. MARSHALL, *Assistant Superintendent Motive Power.*



Longitudinal Section of Boiler.

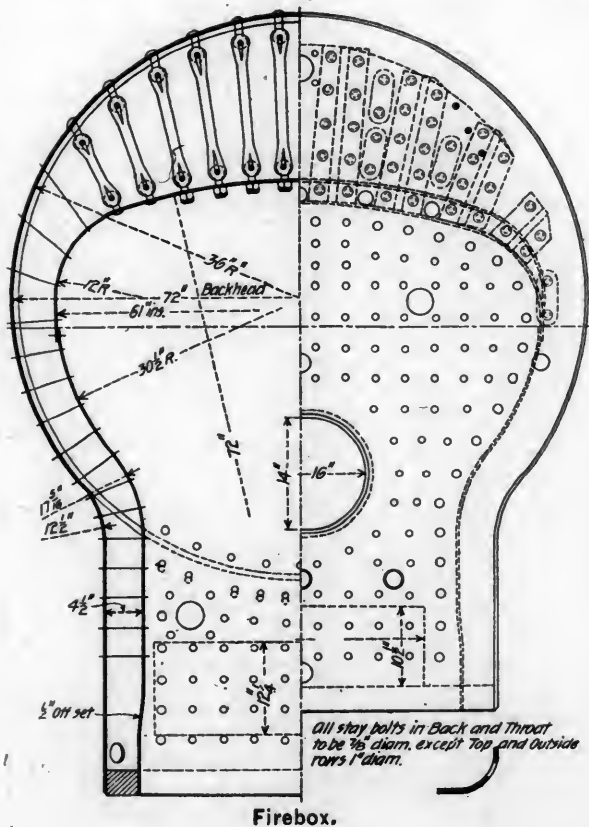
POWERFUL 8-WHEEL PASSENGER LOCOMOTIVES.

Chicago & Northwestern Railway.

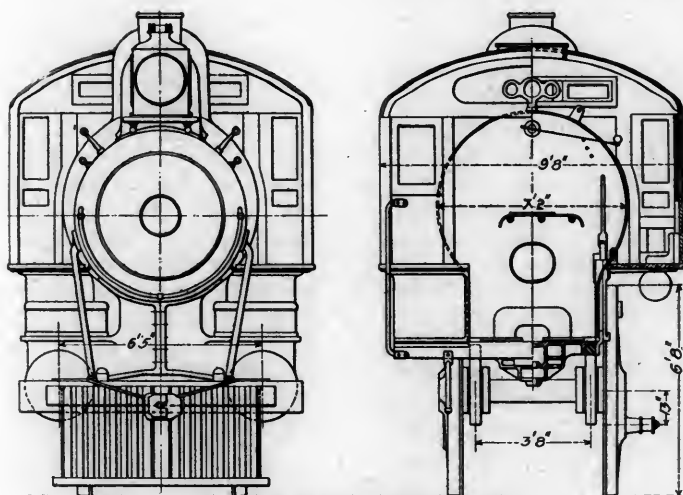
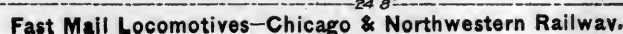
The Most Complete Description Published.

The increase in the power of fast passenger locomotives since the appearance of the New York Central No. 999 in 1893 has been very marked. Our previous issue contained on page 141 a description of the heaviest engine built for this service. The tendency has been toward the Atlantic and ten-wheel types for the heaviest engines, and the two recent designs by the Chicago & Northwestern, built by the Schenectady Locomotive Works, are of unusual interest because of the great power which has been obtained with the eight-wheel type. The question of type is exceedingly important and the Northwestern locomotives are remarkable in that they very nearly approach the maximum capacity in passenger service without resorting to additional wheels. They are the result of efforts to secure the best advantages to be obtained with 8 wheels, and the efforts are apparently successful to a remarkable degree. They represent the best designing we have seen for simple eight-wheel locomotives. To attract attention to these engines it is enough to say that 2,514 square feet of heating surface is carried on 8 wheels. This has never been done before and this heating surface has not been exceeded by that of any passenger locomotives. This heating surface is obtained without excessive length of tubes, and in this connection it is interesting to note that the Burlington engines have tubes 16 feet long, which make the heating surface 2,510 square feet.

The two C. & N. W. designs are for the fast mail and for heavy passenger service. The fast mail engines have 19 by 26-



Firebox.



End Elevations and Sections.

To the information given in the table the following may be added. These engines have the high speed brake, brakes on the truck wheels, Leach's improved sanders, Linstrom's syphons on the tank and no tank valve. Axles are the "Coffin Process," the eccentric straps have Ajax bronze liners, as shown in our May issue (page 155), the smoke box is short, the guides are of the four-bar type and the design makes use of many of the details of the Class A engines illustrated on page 4 of our issue of January, 1896. The weight on drivers of the fast mail engine differed but 200 lbs. from the calculated weight, and the total weight was only 1,200 lbs. from that given by the designer.

General Dimensions.

General Dimensions.

General Dimensions.

General Dimensions.	
Fuel	Bituminous coal.
Weight in working order	133,800 lbs.
Weight on drivers	85,700 lbs.
Wheel base, driving	8 ft. 6 in.
Wheel base, rigid	8 ft. 6 in.
Wheel base, total	24 ft. 8 in.

Cylinders.

Diam. of cylinders	19 in.
Stroke of piston	26 in.
Horizontal thickness of piston	54 in.
Diam. of piston rod	37 in.
Kind of piston packing	Dunbar
Size of steam ports	18 in. x 1 in.
Size of exhaust	18 in. x 3 in.
Size of bridges	1 in.

Valves.

Greatest travel of slide valves	6 in.
Outside lap of slide valves	1½ in.
Inside lap of slide valves	Clearance ½ in.
Lead of valves	¾" lead at 6" cut off.

Wheels, Etc.

Diam. of driving wheels outside of tire.....	80 in.
Material of driving wheel centers	Cast steel
Driving box material	Cast steel
Diam. and length of driving journals	9 in. dia.x1½ in.
Diam. and length of Main crank pin journals	6 in. dia.x6 in.
Diam. and length of side rod crank pin journals	4½ in. dia.x4 in.
Engine truck journals	6 in. dia.x12 in.
Diam. of engine truck wheels	36 in.
Kind of engine truck wheels	Krupp steel tired.

Boiler.

Style	Baker.	Extended wagon top
Outside diam. of first ring	62 in.	
Working pressure	190 lbs.	
Material of barrel and outside of fire box	Carbon steel	
Thickness of plates in barrel and outside of fire box	$\frac{1}{8}$ in.; $\frac{1}{4}$ in.; $\frac{1}{2}$ in.	
Fire box, length	108 ft.	
Fire box, width	40 ft.	
Fire box, depth	front 78 in. back 64 in.	
Fire box material	Carbon steel	
Fire box plates, thickness, sides $\frac{1}{8}$ in., back $\frac{1}{4}$ in., crown $\frac{3}{8}$ in.	tube sheet $\frac{1}{2}$ in.	
Fire box, water space	front 4½ in., sides 4 in., back 4 in.	
Fire box, crown staying	Radial stays, 1 in. diam.	
Fire box, stay bolts	$\frac{1}{2}$ in. and 1 in. diam.	
Tubes, material	Charcoal iron.	
Tubes, number of	320	
Tubes, diam.	2 in.	
Tubes, length over tube sheets	13 ft. 0 in.	
Fire brick, supported on $\frac{1}{2}$ in. Allison special iron tubes 18 in. thick.		
Heating surface, tubes	2164.14 sq. ft.	
Heating surface, water tubes	15.58 sq. ft.	
Heating surface, fire box	173.68 sq. ft.	
Heating surface, total	2353.39 sq. ft.	
Grate surface	30.33 sq. ft.	
Exhaust nozzles	4 in., 6 in., 5½ in.	
Smoke stack, inside diameter	16½ in. at top, 14 in. near bottom.	
Smoke stack, top above rail	15 ft. 2 in.	
Boiler supplied by	two injectors, Monitor "1883."	

Tender.

Weight, empty	46,800 lbs.
Wheels, number of	8
Wheels, diam.	36 in.
Journals, diam. and length	5 in. dia. x 9 in.
Wheel base	16 ft. 10 in.
Tender frame	10 in. channels.
Water capacity	5200 U. S. gallons.
Coal capacity	8 tons.
Total wheel base of engine and tender	51 ft. 11½ in.

[We shall print a list of the dimensions of the heavy passenger locomotives in our next issue.—Editor.]

THE STEEL CAR SITUATION.

By R. P. C. Sanderson

Master Mechanic Norfolk & Western Railway.

A review of the difficulties experienced, now and in the past, in promoting the introduction of the Master Car Builders' standards, shows plainly that many of them were adopted too late and after individual companies, for lack of good standards to use, had put thousands of such parts in use, of an entirely different design, which they could not afterward afford to change.

Some of the old standards, which were abolished a few years ago, concerned old, light equipment, and were not suitable for modern heavier cars, and some of them were practically out of date by the time they were adopted. Those who have had most to do with the design of railroad equipment know that very few cases occur where an original design, no matter how carefully considered, is found to be just right, and the ruthless test of service soon shows that it must be strengthened here and changed there. A standard, if adopted in advance of experience with it, would, in all probability, be found to be defective and require changing in its details. There is a standing committee for the revision of the M. C. B. standards to correct errors, strengthen weak spots and practically keep the standards up to date; thus controlling the modification of the standards by the association instead of leaving each individual to alter them according to his own judgment.

The writer was one of those who, recognizing the above mentioned difficulties, and believing that the steel car frame was near at hand 4 or 5 years ago, hoped that by making a sufficient effort along proper lines, the M. C. B. Association could at least adopt some general standards, which would prevent the worst evils and annoyances that were bound to follow if each railroad company began to build steel car frames according to individual ideas. This would be of little consequence for special cars such as coal and ore hopper cars, as they must be designed to meet special conditions and seldom go off their own roads, or at least make the majority of their mileage on the home roads. It would be, however, of the greatest importance to have at least standard sections and lengths for the principal members of the steel frames for regular interchange cars, box, stock, long gondolas and flats. It would also enable the manufacturers to carry stock ahead, feeling certain of a sale for the same, and would avoid delays with the loss of service of valuable cars for weeks, while awaiting the manufacture and forwarding of some special shape.

After some preliminaries the Master Car Builders' Association appointed a committee to work on the subject, who, after a thorough canvass of all the roads and considering the recommendations of the traffic associations, etc., recommended certain leading dimensions for interchange cars, these now appearing in the published recommended practice to-day, and it is believed are about right for general conditions. It would be interesting to know if those who are building new interchange cars are paying the least attention to these recommendations, and if not, why not?

When the first committee on steel car framing reported to the convention it was evident that that body was not ready to commit itself to any one design, not having given the matter sufficient consideration, and the patent steel car interests were using what influence they properly could to prevent the adoption of a standard which would interfere with their market, and they were right from their standpoint. To dispose of the matter and to make some progress a fresh committee was appointed to submit individual designs, to meet the requirements. At the next convention those designs were submitted, and again the same condition of affairs was brought about, the convention was not prepared to act, had not prepared itself and could not decide such a matter off hand. Something had to be done, so a third committee was appointed

to review these designs and make a final recommendation to the following convention. This committee recommended that the whole matter be dropped for four years, as they felt they lacked experience and knowledge to enable them to decide on any standard form of construction. They were perhaps right and felt that to get up standards for steel car framing might be too utopian an idea, and also perhaps too much of an interference with manufacturers of patented designs of cars. This was the death blow struck in the struggle to get any M. C. B. standards for steel car framing in advance, or at least contemporary with the demand. The results are already plain, and just what was anticipated. Some of the great railroads have placed orders for large numbers of steel framed cars of special designs, manufactured mostly of pressed steel shapes, and this even before a standard axle has been adopted for 100,000-pound cars, so that should the association adopt such a standard it will result in trouble. Some of the cars built may have such an axle under them, the others will not, and the roads concerned are not going to be too anxious to change them to conform to a subsequently adopted standard.

There are many different designs of 100,000-pounds cars and of details for these cars already in use, and more will follow. Each road will alter and improve their details and design, patented or otherwise, along their own lines, as experience directs, so that instead of the practice converging to uniformity it is diverging, and every year that passes makes the matter worse.

As regards the various designs and their merits, one could indulge in a good deal of speculation concerning the good and bad points of each, but as every design is patented, criticism might be considered as "offensive partisanship." Had the association seen its way to adopt one of the designs submitted there would at least have been a design left open for independent use, which is not now available. Any one can substitute steel eye beams or channels for wooden sills and call it a steel framed car, but that is not good design nor is it taking full advantage of the opportunities. Steel requires entirely different treatment in design from wood.

There are the Harvey patents covering steel sills with truss rods and bolsters of his design with multitudinous combinations of this and that, the Pennock patents covering the peculiar features of his designs, the Schoen and Fox patents, which are numerous, covering the use of pressed steel in almost every conceivable combination, and since the association did not want it and finally declined the design with thanks, the center girder design prepared by the writer and Mr. C. C. Wentworth, which was first freely offered to the association, has also been covered by patents for protection.

As the matter stands it would be exceedingly difficult to design a steel car frame now that would be worth the name which would not infringe somebody's patents. So that the steel car frame business is practically in the hands of the manufacturers. Naturally, enough, the writer believes that the center girder and rib, spine and rib, keel and rib, design of frame originally suggested by him and illustrated in the M. C. B. proceedings, is the only correct principle for the design of flat bottomed cars, box, stock, flats, long gondolas, etc., especially for cars of large capacity, and others who have given the question deep thought, and who are not interested either way, directly or indirectly, have strongly approved the design. A number of such cars have been built to put the design to the proof and have shown up well so far. This is so because:

(1.) The greatest strength is in the center line of the car, furnishing ample material, disposed in the most effective way, to withstand any service shocks, and probably any reasonable collision shocks without injury.

(2.) There is no banjo work in the way of truss rods to require tightening; to be in unequal tension, to be bent or damaged in accidents.

(3.) There is nothing about the design but ordinary rolled merchantable shapes, purchasable in the open market, with the simplest kind of shop work.

(4.) The frames may be ordered in lots from any good bridge shop and shipped by the carload to the car shops or railroad shops to be unloaded off the cars by a hoist, dropped directly on to the trucks and run into the car shops to have the superstructure, brakes, etc., added.

(5.) There is the greatest possible strength for the minimum of weight (less weight than a weaker timber frame).

When we come to ore and coal hoppers, however, the problem is entirely different. There the sides must, perforce, be very strong to retain the load and to resist the lateral pressure of the load. The material, whether wood or steel, has to be there for this purpose anyway, and we should take advantage of the vertical strength lying dormant in this unavoidable material to help carry the load. We should add a little to the strength of the bolsters to transmit the load back to the center plate, making the center sills heavy enough to take the pulling strains and service shocks only; they need not carry any of the load beyond that small portion which lies directly over them where they pass through the hopper.

The question of whether in cars of this class the hopper bottoms and sides should be made of steel or of wood is one upon which there is a great difference of opinion, which it will take a good many years of experience to finally settle one way or the other. At the rate that cars of 100,000-pound capacity are now being put into service with steel hoppers and wooden hoppers, five or six years will give us a pretty positive answer to this question, if the railroads using them will keep record of the performance of these cars, the cost of repairs and the kind of repairs, which they are pretty sure to do.

[Before this article was written Mr. Sanderson expected to describe the steel frame cars to which he refers, but the drawings were not completed in time. They were received later, and an illustrated description of the design is given on page 187 in this issue.—Editor.]

MILEAGE OF CHILLED CAST WHEELS IN FREIGHT AND PASSENGER SERVICE.

For several years we have been favored by Mr. J. N. Barr, Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Railway, with the mileage records of chilled cast iron wheels in passenger and freight service. He has sent us the records for 1898 to bring these up to date.

In presenting this record in previous years we have directed

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY,
OFFICE SUPERINTENDENT MOTIVE POWER. }
STATEMENT SHOWING SERVICE OF FREIGHT CAR WHEELS.

Year.	Number of freight wheels made or bought.	Freight car mileage	Number of freight cars.	Number of freight wheels in service.	Average mileage.	Average life of wheels.		
						Year.	Month.	Days.
1885	22,395	215,459,302	19,402	155,216	76,968	6	11	15
1886	19,459	236,140,449	21,385	171,080	97,080	8	9	15
1887	24,721	250,774,965	21,678	173,424	81,152	7	0	1
1888	24,162	261,400,022	22,544	180,352	86,544	7	5	17
1889	26,015	250,990,286	22,776	182,208	77,184	7	0	1
1890	15,823	263,983,845	23,864	190,912	183,468	12	0	24
1891	12,810	305,482,841	25,674	205,392	190,776	16	0	12
1892	17,340	334,943,674	26,308	210,372	154,528	12	1	18
1893	17,332	312,593,242	27,963	223,612	144,240	12	10	24
1894	11,647	276,370,355	27,800	222,400	189,784	19	1	4
1895	14,219	289,316,350	27,687	221,408	162,776	15	6	26
1896	19,569	315,810,431	27,645	221,072	129,104	11	3	22
1897*	14,634	292,285,995	27,517	220,048	159,784	15	0	13
1898*	19,420	344,752,791	30,120	240,876	142,020	12	4	25

* These records are on fiscal year basis.

attention to the fact that the average mileage is obtained by dividing the total car mileage during the year by the number of wheels taken out. If 10,000 wheels are in service, and 1,000 are removed each year, the average length of service would be 10 years, and the average mileage would be ten times the yearly mileage of the cars. As previously explained, this does not

STATEMENT SHOWING C., M. & ST. P. RY. CAST WHEELS IN PASSENGER SERVICE.

All Wheels Scrapped Except for Sliding.

Year.	Passenger.		Bag. mail and express.		Parlor and sleeper.		Total.	
	No. of wheels.	Average mileage.	No. of wheels.	Average mileage.	No. of wheels.	Average mileage.	No. of wheels.	Average mileage.
1885	840	46,068	811	45,641	65	42,708	1,676	45,731
1886	513	67,040	500	73,380	45	77,192	1,058	70,468
1887	391	80,243	470	88,379	28	96,366	889	85,033
1888	378	92,240	449	107,376	9	99,879	836	100,455
1889	455	100,864	477	112,031	9	141,706	941	106,916
1890	529	97,808	535	106,161	17	96,291	1,081	101,919
1891	892	96,919	885	109,673	51	102,605	1,828	103,252
* 1892	1,118	101,386	1,015	111,883	61	95,502	2,194	105,852
* 1893	1,088	99,139	1,092	110,858	29	122,998	2,219	105,218
* 1894	1,303	107,688	1,046	112,979	38	107,265	2,387	109,909
* 1895	1,144	106,949	1,002	114,542	48	93,715	2,194	110,127
* 1896	1,293	107,793	1,211	115,633	126	103,875	2,633	111,215
* 1897	1,518	101,248	1,439	110,136	182	99,994	4,139	105,250
* 1898	1,275	103,188	1,275	104,921	141	92,215	2,691	103,434

All Wheels Scrapped on Account of Sliding.

1885	640	23,936	543	18,218	96	12,514	1,279	20,654
1886	363	31,525	220	33,106	24	23,968	607	31,601
1887	337	44,467	324	48,352	12	68,080	673	46,759
1888	535	48,866	434	49,940	17	32,978	986	49,064
1889	591	51,566	346	60,705	4	49,874	941	54,936
1890	354	47,277	250	51,110	2	5,940	606	48,722
1891	466	49,142	271	48,573	44	38,770	781	48,360
* 1892	586	48,197	397	45,492	30	30,678	1,002	46,821
* 1893	715	38,307	419	42,302	25	44,536	1,159	39,886
* 1894	653	43,753	366	42,842	44	29,679	1,063	42,610
* 1895	613	37,818	218	52,967	78	29,882	909	40,771
* 1896	382	38,280	219	43,188	125	32,392	726	38,747
* 1897	730	34,660	274	33,876	247	22,077	1,251	42,004
* 1898	736	36,724	292	45,096	182	30,529	1,210	37,812

All Wheels Scrapped.

1885	1,440	36,232	1,354	36,642	161	23,329	2,955	34,385
1886	876	54,322	720	61,047	69	58,618	1,665	56,339
1887	728	63,684	794	72,406	40	87,881	1,562	68,554
1888	913	66,827	883	79,146	26	56,091	1,822	72,645
1889	1,046	73,027	823	90,459	13	113,450	1,882	80,798
1890	883	77,437	785	88,629	19	86,790	1,687	82,750
1891	1,358	80,524	1,156	95,515	95	73,029	2,609	86,887
* 1892	1,704	82,508	1,412	92,133	100	73,727	3,276	86,479
* 1893	1,813	75,151	1,511	92,460	54	87,044	3,378	83,056
* 1894	1,956	86,207	1,412	94,799	82	65,684	3,450	89,235
* 1895	1,757	89,086	1,220	102,866	126	54,199	3,103	93,219
* 1896	1,675	91,840	1,430	104,538	251	68,674	3,356	95,568
* 1897	2,248	79,181	1,713	97,921	429	55,134	4,390	84,143
* 1898	2,011	78,863	1,567	93,773	323	57,457	3,901	83,080

* Fiscal year basis.

give accurate figures for any particular year, but it does give a correct method of comparison when a number of years are covered, and the statement shows the average mileage of all wheels taken out for all causes.

The average mileage for the past nine years is much larger than before that period, and there is a variation between 133,000 and 190,000 miles in the nine years. It has already been pointed out that between the years 1889 and 1890 there was a sudden jump in the figures, which is probably due to the introduction of the contracting chill, which has been used for a large proportion of wheels cast since that time.

The new Burlington fast passenger locomotives illustrated on page 141 of our May issue, we are informed by Mr. Delano, are not to be used in the fast mail service at present, but will go into the regular passenger and mail train pool between Chicago and Burlington, 206 miles, and they may be used for the fast mail service later. They will haul the Denver limited, leaving Chicago at 1.30 P. M., the time card schedule of which is 3 hours 55 minutes from Chicago to Burlington, with 11 stops. From Chicago to Aurora the train has 9 cars weighing 371 tons, and from Aurora to Burlington 34 tons less with 8 cars. Mr. Delano writes that in warming up one of these engines recently the run from Mendota to Aurora, 46 miles, was made in 48 minutes, with a 10-car train, weighing a little more than 400 tons, which is a remarkable performance for a new engine.

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THE DESIGN OF CAST IRON CAR WHEELS.

With the exception of improving the metal and increasing the weight of cast iron car wheels, little or nothing has been done to improve their strength and ability to withstand the increased stresses brought upon them by the greater severity of shocks in present service, which are due to the use of cars of large capacity. An analysis of the stresses produced in cast iron wheels by the loading, brake shoe pressures and other forces is presented in this issue by Mr. Grafstrom, whose painstaking work in this direction suggests the importance of the examination of present practice in the design of wheels of this type with a view of improving them structurally. The motive power officers of roads operating over long mountain grades are exceedingly anxious about their wheels, owing to the combined effect of heavy loads and the heating of the brake shoes.

Notwithstanding the importance of this subject, very little

has been done experimentally to show the effects of varying the design of wheels and the admirable report made to the Master Car Builders' Association in 1892 by Mr. H. J. Small of the Southern Pacific Company is very valuable in this connection, and his conclusions are more important now than when they were drawn, notwithstanding the improvements which have been secured by the introduction of the thermal test.

In the experiments referred to it was found that the cracking of the wheels was mainly due to the difference of temperature in the rim and hub. The cracks almost invariably started in the outer plate and within the junction of the inner plate. With the usual pattern of wheels the rim is expanded by the brakes and a force acts outwardly about in the plane of the middle of the single plate. On the outside of this plate there is not always enough metal to resist the expansion of the rim, while on the other side the rim is bound to the hub by the brackets, and these being exposed on three sides to the air, which is in rapid circulation, are more favorably situated for remaining at a lower temperature than corresponding parts of the single plate. The cool ribs seem to resist the expansion of the rim of the wheel on one side of the single plate and, there being no resistance on the other, the effect appeared to be to prevent the diameter of the tread of the wheel next to the flange from increasing as much as the outside of the tread. A contributing cause of cracking at the junction of the plates was the inferiority of the metal at that point on account of the porosity that resulted from the method of pouring.

Mr. Small suggested the use of less metal in the ribs, either by decreasing their number or their size, the use of the S bracket, which requires less force for extension of its length than the curved brackets and the extension of the single plate nearer the outside rim of the wheel. The results of tests showed conclusively that the design of wheels embodying these suggestions improved the ability to resist the effects of heating and when a large number of these were placed in service further support was obtained.

Mr. Grafstrom's analysis may be applied to the design of wheels and if combined with as careful experiments as those referred to it is probable that even better results may be had. The cast iron wheel has contributed in a very important way to the development of American railroads, and it seems wise that it should be improved to keep up with the increased severity of the demands imposed upon it.

A RESEARCH LABORATORY.

By M. N. Forney.

When the trees put on their summer attire and strawberries come to market, many of the readers of the American Engineer begin to think of the annual conventions of the two associations which assemble in June. This year they will meet at Fortress Munroe, where they have been held several times before.

Referring now to the Master Mechanics' Association, the list of subjects to be reported on are as follows: 1. A Research Laboratory Under the Control of the Association. 2. Boilers and Water Impurities. 3. Cast Iron and Steel-tired Wheels. 4. The Ton-mile Basis for Motive Power Statistics. 5. Staybolts. 6. Flanged Tires for Locomotives. 7. Best Form for Fireboxes, and 8. Nickel Steel.

The first subject is an old one, which was up for consideration twenty-six years ago. Inasmuch as there are now only a very few members who know what was done then, before the merits of the measure will be discussed, a brief résumé will be given of the action—or rather non-action—at that time.

In 1873, at the meeting held in Baltimore, a report was made on Water Purification, by a committee of which Mr. H. A. Towne was chairman. The report indicated that he had incurred some expense in preparing it, and Mr. Glass therefore moved "that Mr. Towne be reimbursed for the amount expended by him." No action apparently was taken on this mo-

tion. Afterwards another was made by Mr. Howard Fry, to the effect "that the committee be requested to appoint one of its members to receive from any member of the Association such specimens of water as he may require to be analyzed, to have it tested by some competent chemist, and return the analysis to the Master Mechanic sending it, the test to be made at the expense of the company with which the Master Mechanic is connected."

In discussing this motion Mr. Wilson Eddy observed, satirically, that "it would doubtless be a great satisfaction to our men in Boston to know that they can send water for analysis out to Omaha, or Chicago, or somewhere else. Possibly, though, they might think there were chemists nearer home who could do the job just as well. I think the railroads should select their own chemist to analyze their water, at their own expense."

Notwithstanding Mr. Eddy's opposition, the motion was carried, but afterwards Mr. Setchel moved "that no expense shall be incurred by committees except by the unanimous consent of the General Supervisory Committee, given in writing to the chairman of said committee, stating the amount to be expended." This also was carried. Later in the session, in discussing the need of a dynamometer, Mr. W. A. Robinson observed that "the time has come for the establishment of something of the kind to enable the members of the Association to make such practical experiments as they may deem necessary," and he then moved "that a Committee on Mechanical Laboratory be appointed by the President, and that this question be referred to that Committee." This motion also was carried, and later Mr. Robinson, Mr. Reuben Wells and Mr. J. M. Boone were appointed such a committee, which was afterwards increased by the addition of N. E. Chapman and H. M. Britton. At the meeting of the Association, in Chicago the following year—1874—this committee made an elaborate report. Accompanying the report was a communication from Professor Thurston, who was then connected with the Stevens Institute of Technology, in Hoboken, and one from the trustees of the Institute, in which it was proposed to establish a "Laboratory for Technical Research" in connection with that institution. It was proposed by the trustees to give the required space for such a laboratory, either within the present buildings or upon their grounds, and grant the use of all facilities for investigation possessed by the Institute. They also agreed to assist in the organization of the scheme, and, under proper restrictions, to assume the responsibility of its government and safekeeping. The committee very modestly estimated the cost of the apparatus at about five thousand dollars, "more or less," and apparently foundered on the rock of how even this modest sum could be raised.

A second paper by Professor Thurston on "The Necessity for a Laboratory for Technical Research" was appended to the committee's report. It contained among others the following wholesome observations: "The formation of a plan of operations requires a very definite knowledge of the character of the problem and an accurate understanding of the relative importance and probable bearing of the anticipated results." He also said—what seems hardly to have been realized by the advocates of the measure—that "The investigator must first know definitely what phenomenon it is proposed to investigate."

The trustees of the Stevens Institute reiterated their offer, and agreed to appropriate to the use of such a laboratory a strip of land adjacent to the Institute, having a value of about \$20,000, on which the requisite buildings could be erected. Liberal offers of aid in organizing and conducting it were also made. The report with its appended communication excited a long and animated discussion. Mr. Eddy wanted to know how the money was to be raised, and said that "Many of us are liable to belong to the association only a year or two," and that the membership was constantly changing. Continuing, he added: "If we ask our respective companies to contribute to

us, so that we can control apparatus for these various purposes, will not they tell us that they had rather we would use our education to determine a more economical way of hauling freight, or something of that kind, rather than to be spending our time and their money for something in the direction proposed."

The strongest argument was made by Mr. Coleman Sellers, who coincided with Mr. Eddy in thinking that "the society is a very evanescent one; it is one dependent upon people holding certain positions, and they remain active members so long as it is to their advantage to be mechanical engineers connected with railroads, but if they should leave that position, in all probability their interest would be diverted from it. The association exists totally different from such a society, as we may say, the Franklin Institute, which is a society having a location and building, and its members, of course, die off, and others are added to it, but its vocation remains fixed. Such an institution can very well collect about itself a laboratory and apply it to the use of its members. But there seems to me a great many difficulties in the way of attaching a laboratory to an institution that is merely formed with men who come together because they are in a particular trade, and that is the position held by this Master Mechanics' Association. . . . Properly fitted up laboratories exist all over the country, and to them these matters can be referred."

Mr. Jackman expressed the opinion that "unless we should do something more than superhuman, we could not accomplish very much more than what is accomplished from year to year by those who do examine these subjects, and publish the results of their examinations, so that the whole world can have the benefit of these results. . . . Inasmuch as there are many chemists employed all the time, and as they are publishing from time to time the results of the experiments they make, is it possible, or if possible, is it probable that we should get any better results than what we get through these chemists, who are all the time engaged in this business, and give us their tabulated statements, and who give us the results of all the experiments they make?"

Repeating, Mr. Sellers added, "The very fleeting nature of our association, the constant change of membership, and their wide separation, involves difficulties that it is very hard to overcome."

When the discussion was ended a motion was made to refer the subject back to the committee to report at the next annual meeting, which was carried. At the succeeding meeting, held in 1875, in New York, the committee reported that "After a careful reconsideration, they deem it the wisest course at the present time to recommend that this subject be postponed, indefinitely or until surer prospects exist of its being successfully carried out," and the project was then dead, to be resuscitated twenty-four years afterwards. The scheme then received careful and candid consideration, and most of those who advocated it, and the writer was one of them, were then convinced that it was impracticable. If it was so at that time, is it probable that it is less so now?

The weakness of the enterprise was pointed out by Mr. Sellers, and was then, and it is thought still, is due to the "fleeting and evanescent" tenure of membership in the Association, and the consequent lack of responsibility of those who might be called upon to take charge of its direction. Persons competent to successfully conduct experimental research are rare individuals, and to secure the services of such persons would require the most intelligent and disinterested discrimination and discernment. If a director of research was to be selected, what probability is there that the best or even a good man would be chosen? The world produces very few men competent to make original experimental researches, and the ability to recognize such capacity is almost equally rare. Now there are three ways by which a person could be selected for such a position by the Association. One would be to have him elected by the members—that is, by the counting of noses; or by appointment either by the executive or some special com-

mittee. In any one of these methods it is very far from probable that the persons whose votes would select the director of research would be entirely competent judges of the qualifications which such a person should have. The chances are that some one would be chosen for the position because he is a good fellow, or is a master mechanic out of a job, or some one who is the exponent of some interest, which could be served by the researches to be made.

The original scheme proposed by Prof. Thurston contemplated that "the personnel of the laboratory should consist of a director, with able assistants, good mechanics to take charge of tools and some unskilled labor." The employment of such a corps and their work would have involved the expenditure of a good deal of money, and this necessarily would have incurred a grave responsibility on the part of the Association. This was clearly recognized when the measure was fully and impartially considered twenty-five years ago, and as a consequence the association then declined to incur the responsibility, and the whole matter was "indefinitely postponed," or, as the committee said in their final report, "until surer prospects exist of its being successfully carried out." Since then the scheme slumbered until the meeting of 1897. When a motion was made and carried that a committee should be appointed to report at the next annual meeting on a "Research Laboratory Under Control of American Railway Master Mechanics' Association." Notwithstanding this action, this subject was not included in the list of those "for the 1898 convention" published in the first pages of the 1897 report. It is, however, the first in the list of subjects for the 1899 meeting, which is printed at the beginning of the 1898 report. Why this hiatus occurred in the appointment of the committee is not apparent. At any rate, the report to be read at the meeting this year will probably recommend substantially what the old committee proposed in 1874, with this important difference, that the estimated cost of the project has increased from \$5,000 to \$40,000 or \$50,000, and the annual expense of operating or conducting it would be about \$25,000 per year. It is also proposed that there shall be a manager in charge who is to be the Director of Research, assisted by a chief physicist or engineer in charge of physical tests; a chief chemist in charge of chemical tests. Under these men should be an ample corps of able and capable assistants. It is to be feared that with such a corps the annual expenses suggested would be quickly melted away in salaries.

That the end contemplated is a very desirable one is of course conceded. If an organization could be formed to which the doubtful and perplexing questions and problems which arise in the operation of railroads could be referred, and solutions obtained, it certainly would be a very desirable accomplishment. It is because it seems so very doubtful whether such an organization as is proposed will, or can, accomplish the ends aimed at that this article is written.

It may be suggested that the Executive Committee of the Association should have charge of the work of the Committee of Research. Now, the former committee, as Mr. Sellers said years ago, is an ephemeral one, its personnel and character is changed each year, and those composing it are not always selected because of their scientific sagacity, but much oftener merely as a compliment to members, because they are good fellows—which they generally are—and hold some official position on a railroad.

It would take too much time and space to describe fully here the qualifications which a competent Director of Research should have. To do anything which is worth doing he must be a real genius. When a person is recognized as a master of research, he at once becomes distinguished, and it is not then easy to hire the services of such a person. Let us suppose that it is decided to establish such a laboratory, and that in order to secure the services of the most competent person, the Executive Committee should determine to make their wants known and should undertake to formulate an advertisement

for such a director. It can be imagined that it might read somewhat as follows:

WANTED.—A person to fill the position of Director of Research in the laboratory of the American Railway Master Mechanics' Association. He must have the following qualifications: A thorough technical education, and be able to write English clearly and lucidly (which most technically educated people cannot do), and know French and German. He must have had ample practical experience in a machine shop, and have a sufficient amount of inventive ability to be able, at all times, to "make a scientific use of his imagination" in the investigation of abstruse problems. Besides being an inventor, he must have the judicial and logical faculties sufficiently developed to be able to reason correctly and draw sound and unerring deductions from large numbers of phenomena and facts under his observation and ken. An important characteristic of his mind should be "dead-sureness," but allied with it there should be great alertness of body and mind for the apprehension of all kinds of phenomena, and their relation and effects. He must be able to take an enthusiastic interest in any subject presented to him for consideration and "research," and have unlimited pertinacity in the pursuit of the truth. Besides these qualifications, he must be amiable and civil, and capable of being all things to all men, and expect to be an unresisting target for the remarks of all sorts of ill-natured people who envy him his position. Added to these traits, he must be invulnerable to gifts and bribes and morally invisible, so that he cannot be "seen."

These are only some of the qualifications which a Director of Research should have. What chance is there of securing the services of such a man, at a salary of a few thousand dollars a year? Men of that kind may exist, but it is difficult to hire them; and yet the scheme is likely to fail unless it is in charge of some such person.

What has been said is not intended to imply a disbelief in the value of experimental research, but only to the method proposed for conducting it. As a matter of fact the British Institution of Mechanical Engineers has, for years past, conducted very successfully a series of the most valuable researches on various subjects. The method is simply this—some subject is selected on which research is desirable and more information is needed. A Research Committee is then appointed on that subject which is charged with the duty of conducting experimental investigation with reference thereto. Appropriations to meet expenses are made by the council, as seems to them judicious, and the committees employ such assistance as they require, of course with the sanction of the council. Committees of Research have been appointed on the following subjects: Boiler Seams and Riveting Friction; Marine Engine Trials; Steam Jackets; Alloys; and Gas Engines. Elaborate and very valuable reports have been made on each of these subjects.

Now, under this method of conducting research, the Institution is following the recommendation of Prof. Thurston, to wit: that "the investigator must first know definitely what phenomenon it is proposed to investigate." It would, it is believed, be much wiser and more practicable for the Master Mechanics' Association to act in accordance with this advice; and the practice of its sister organization, than to embark in an extravagant scheme which will lead to results which no one can foresee, and which would be liable to abuses which might bring discredit to the Association and its members.

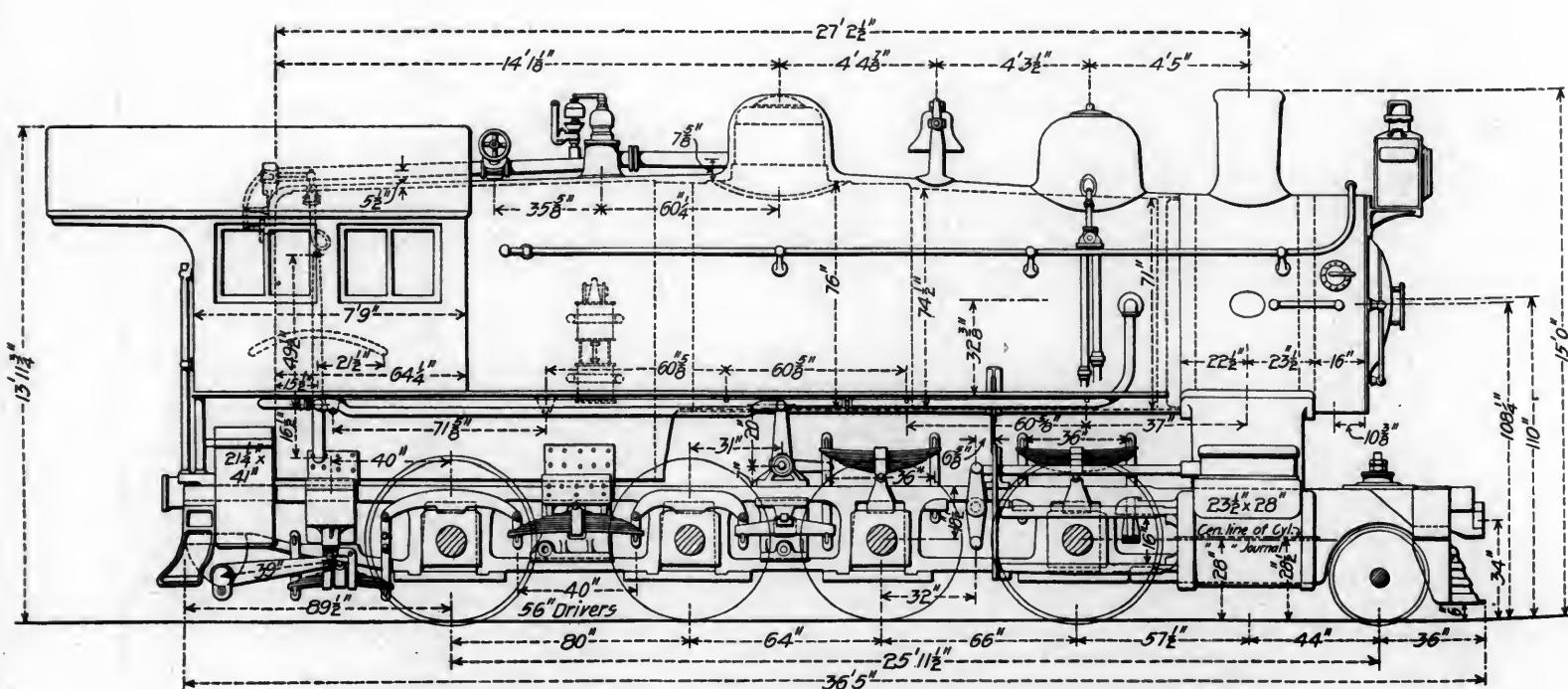
The plan of the Institute of Mechanical Engineers is very simple, and could very easily be adopted and tried, and, if successful, could be extended, or if it failed would not incur any disastrous consequences. Such a plan was proposed in these pages a year ago, in an article on Competitive Tests of Locomotives. It was then suggested that a series of such tests should be made under the auspices and direction of a committee to be appointed for that purpose—the committee to formulate a plan for making the tests, and have charge of them, and

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CLASS H 5 FREIGHT

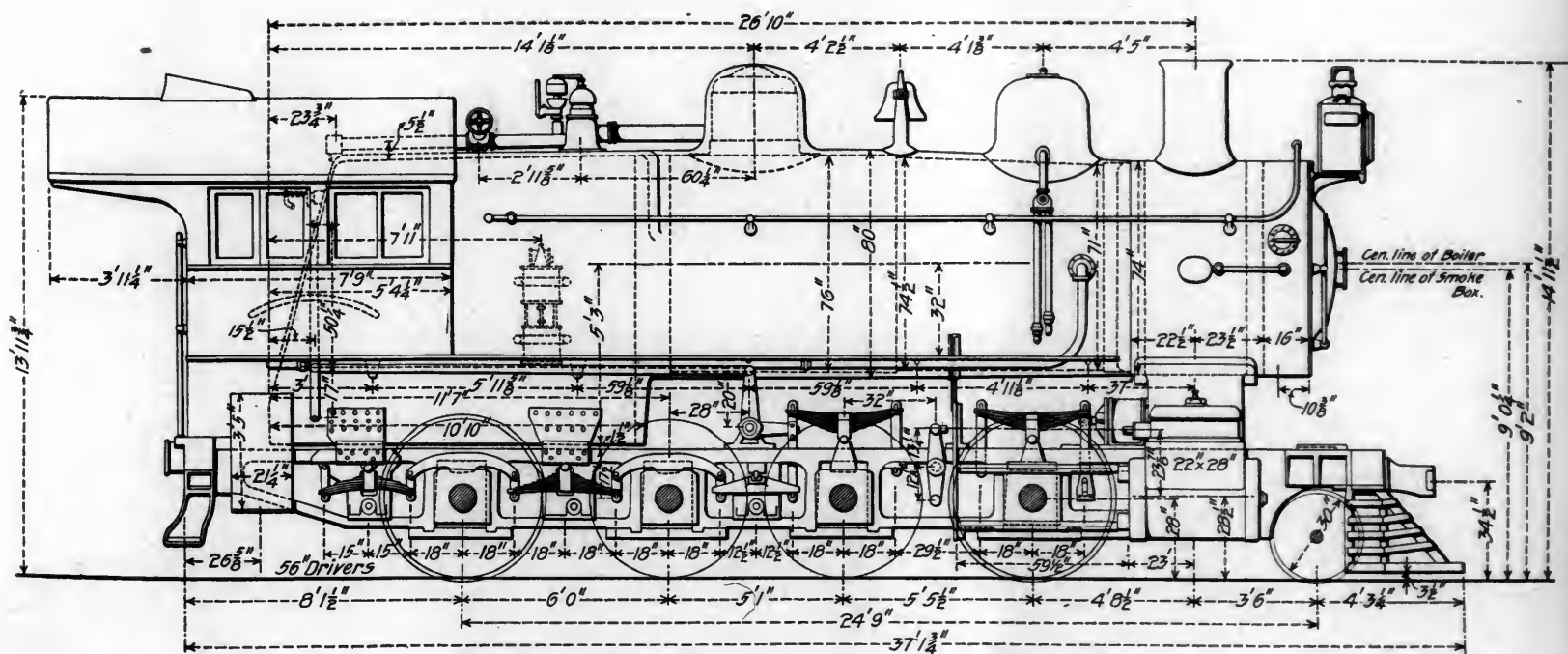


CLASS H 5, FREIGHT LOCOMOTIVE.—FOR MOUNTAIN PUSHING SERVICE.—FIG. 2.

STANDARD CONSOLIDATION LOCO.



IGHT LOCOMOTIVE.—FIG. 1.



CLASS H 6, FREIGHT LOCOMOTIVE.—FOR ROAD SERVICE.—FIG. 3.

direct how they should be made. As such tests would occupy weeks or months, the committee would not be able to give the time required to personally conduct the series of experiments, and therefore it was suggested that they be authorized to employ some competent person or persons to take charge of them, of course under the direction of the committee. In the article referred to it was said further that "probably no competent person could be found to take charge of such work who would be willing to give the time to them which would be required without compensation, and therefore the mechanical expert and his assistants would have to be paid. This would imply that some money must be provided for such, and some few other expenses. The committee should therefore be authorized to raise and expend money for the purpose contemplated, with the usual powers and responsibilities of an auditing committee."

In his annual address last year, President Leeds made a similar recommendation, but it was not acted upon. It is urged here that such a measure would inaugurate the system of Experimental Research, so successfully adopted and practiced by the British Institution of Mechanical Engineers, that it could be done with very little cost or risk of disaster, and, if successful, the method of investigation could be extended to other subjects; and, if the appliances of a mechanical or chemical laboratory were at any time needed, those already in existence could be resorted to; and there can be little doubt that the services and assistance of the persons in charge of them could in most cases be obtained. It may very well be that in the prosecution of such research that some special apparatus or appliances not to be found in any of the laboratories might be required. If that should be the case, it will then be early enough to consider the ways and means of getting what is needed.

The purpose of this article is to suggest that the committee making the report this year should accept Prof. Thurston's recommendation and formulate "definitely what phenomena it is proposed to investigate," and then have a special committee or committees of research appointed to investigate such phenomena, utilizing as far as possible existing laboratories, without contemplating any expenditure for experimental appliances, excepting for such kinds as are not now in existence and may be needed in the future.

A good subject to begin on would be "Competitive Tests of Locomotives," which was proposed last year.

So much room has been occupied in the discussion of the first subject for consideration at the Master Mechanics' convention that it is impracticable to consider the others, which will be reported on, and which it was at first intended to discuss in this article.

THE IMPORTANCE OF HIGH PRESSURE IN FUEL OIL BURNING.

Almost any morning outside of a certain large manufacturing plant in Philadelphia in a side street may be seen a heap of black refuse, which has just been dug out of some 50 or more oil furnaces used in the works in forging, etc. Ordinary passers-by would be shocked to learn that this represents a value in fuel, that has to be paid for, of over \$60 at a very moderate estimate. This waste is the carbon which forms in such furnaces where the combustion is incomplete. The fires in this case are smoky and the furnaces are soaked with oil that is spattered about, indicating at once that something is wrong with the method of burning the oil, although we are told that this is most excellent in efficiency and "entirely satisfactory."

Contrasted with the above the writer inspected some oil furnaces in a little country place, where few persons would see them without a special pilgrimage. It was a small plant with only five or six furnaces. There was no smoke, no smell, and the fires were at a white heat, turning out evidently at least three times the amount of work per hour that could be done in the ones first described. On rubbing a white handkerchief around the glazed walls inside of one of the furnaces, which happened

to be out of use and cool, no spot or soil could be found on the handkerchief, and this indicated complete combustion.

This system, like the first, is an evolution, but an evolution from a different root. It could not have come from the low pressure system, for all its principles of action are unique. It is rather the outgrowth of the experiments instituted in the 5 or 6 years just past, when compressed air was discovered to be possessed of the properties required for burning oil properly. These experiments have all in turn been rewarded by quick responses, and a new set of progressive data obtained from them, all in the direction of increased economy. It may prove instructive to consider the two best types of low pressure and high pressure systems of oil burning.

The low pressure system is operated by blower blast, and as the pressure is only about 6 to 8 ounces, only a very ineffectual breaking up of the oil can be attempted. Much of the fuel therefore is blown in to the furnace in solid drops, from which low heat efficiency is obtained. The finer portions of the spray, mixed with the air in the blast, may burn to produce a temperature as high as 2,500 degrees, but rarely so much as that, and this will mean about 4,000 heat units per pound of oil burned. The drops make carbonic acid. If this carbon could all be burned the temperature of the furnace would rise to over 4,000 degrees and the heat units would be 12,000 per pound; this is a difference of 8,000 units which are lost. These are sufficient to heat 16 pounds of iron to a welding heat, or in one furnace it would add 4,800 pounds to the output of work per day. This is a pretty large loss, unless the carbon can be sold at what it costs to make.

In the second case mentioned, which may be very properly regarded as the highest development of the compressed air systems, the first remarkable feature seemed to be the fine atomization, under an unusually high pressure, 25 to 30 pounds, the oil being delivered at just enough pressure to insure a solid supply at the burners, about 5 or 6 pounds. The jet formed was driven through the atmosphere from about 5 inches away from the funnel entrance to the furnace, inducing free air in a ratio due to the velocity of the jet, and it was lighted with a torch. The combustion seemed to be absolutely perfect from the start and the temperature picked up very rapidly to a high degree, constantly increasing until the furnace was white hot. As there was no smoke and no carbonic oxide formed, there must have been, according to the laws governing carbon combustion, a temperature making carbonic acid, and as there is 84 per cent. of carbon per pound of oil, this would mean 84 per cent. of the heat units belonging to the pound of carbon under perfect combustion, or 84 per cent. of 14,500, which means 12,180 heat units secured.

There is also 14 per cent. of hydrogen liberated from a pound of oil and it is fair to expect that by the extra induction of air at the right point this combustion could also be and probably was secured, which gives 14 per cent. of the 62,000 heat units belonging to the pound of hydrogen, or 8,680 units. Then 12,180 (the carbon heat units), plus 8,680 (the hydrogen units), gives a total of 20,860, or all there is to be gained from the fuel (the 2 per cent. of nitrogen in the pound of oil being valueless).

This seems to be an ideal method, and although probably no furnace can be constructed to utilize all this heat, yet there seems to be encouragement to expect that at last something like finished results are in sight from the use of oil fuel. A description of the high pressure method whereby 30 pounds of iron were heated (to a welding heat), per pound of oil, at the Juniata shops of the Pennsylvania Railroad at Altoona is given on page 42 of our issue of February, 1897. It is perfectly safe to say in this connection that very few people who are using oil know the ratio between the amount of iron heated and the quantity of oil burned. It is also safe to say that in ordinary low pressure systems not more than 15 pounds of iron are heated by each pound of oil.

The well-known firm of H. K. Porter & Co. has been succeeded by H. K. Porter Co., with Mr. H. K. Porter President.

CAR WHEEL CONSTRUCTION.

By Edward Grafstrom.

A great deal of progress has been made in recent years in the manufacture of cast iron car wheels. With the growing demands of traffic the railroads have from time to time tightened up their specifications and insisted on more stringent tests. New requirements have generally been met by changes in the metallurgy of the wheel, while its mechanical construction and its form has practically remained the same as the original Washburn or Atwood pattern, which, since the drop test drove the single-plate wheel off the market, has become the generally accepted standard for ordinary service.

The introduction of contracting chills did not bring about any change in the form of the wheel, nor did the adoption of the thermal test. The broad tread wheel with its $6\frac{1}{4}$ -inch rim has passed, and the Master Car Builders' Association has defined the contour of flange and tread. The length and bore of the hub are determined by the axle, and weight limits have been decided upon. Otherwise there is no general agreement between the railroads and the manufacturers as to the form of the wheel, yet there seems to exist a tacit understanding that the Washburn type with ring core and curved brackets is the proper wheel of the present day. The size and shape of the ring core may vary, as well as the number and curvature of the brackets, and the thickness of the plate, but the general design remains the same. With the introduction of 80,000 and 100,000 pounds cars stronger wheels were needed. The old patterns were re-enforced a little all around, the plate was made heavier and perhaps a couple of brackets were added.

The writer has recently been asked the question more than

once where added metal will do the most good on a car wheel. The scrap yard gives the reply in a way, but to get the best distribution of the iron requires a careful analysis of the stresses which may be produced in the wheel, as far as they can be determined. Those caused by external forces are more or less known, but the internal strains are apocryphal; to what extent they are reduced in the annealing pit is uncertain, but it is here suggested that if, by suitable manipulations of the metal while cooling, these stresses can be brought under control as to magnitude and direction, they may, instead of being detrimental to the structure, add strength to it by counteracting the effects of the external forces, in the same manner as the initial strain produced by the camber assists the car-sill. For the present, however, these stresses must necessarily be left out of consideration.

The writer has never yet seen in print any calculations for a car wheel; the following analytical method is therefore offered, the value of which depends wholly upon the accuracy of the data available. For the purpose of representing extreme conditions surrounding a car wheel in actual service under a 30-ton car, a box car is assumed weighing 32,000 lbs. and carrying the maximum load of 66,000 pounds, making a total of 98,000 pounds. The car-body weighs 21,000 pounds, and its center of gravity, as recently determined by Mr. A. S. Vogt, of the Pennsylvania Railroad, lies 5 feet 6 inches above the top of the rail. The two trucks weigh together 11,000 pounds, and their center of gravity is, according to the same authority, located $19\frac{1}{2}$ inches high. For the lading the corresponding distance is assumed to be 6 feet. The center of gravity of the total weight of 98,000 pounds will thus be found to be 5 feet 4.82 inches high, as shown in Fig. 1.

Going at a rate of 60 miles per hour around a curve of 1,000

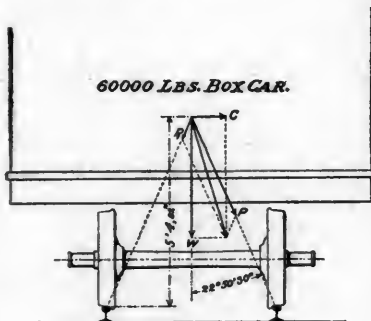


Fig. 1.

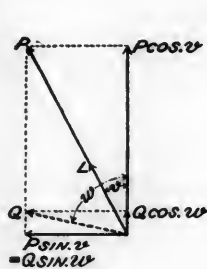


Fig. 4.

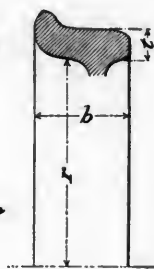


Fig. 5.



Fig. 6.

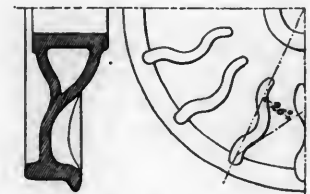


Fig. 7.

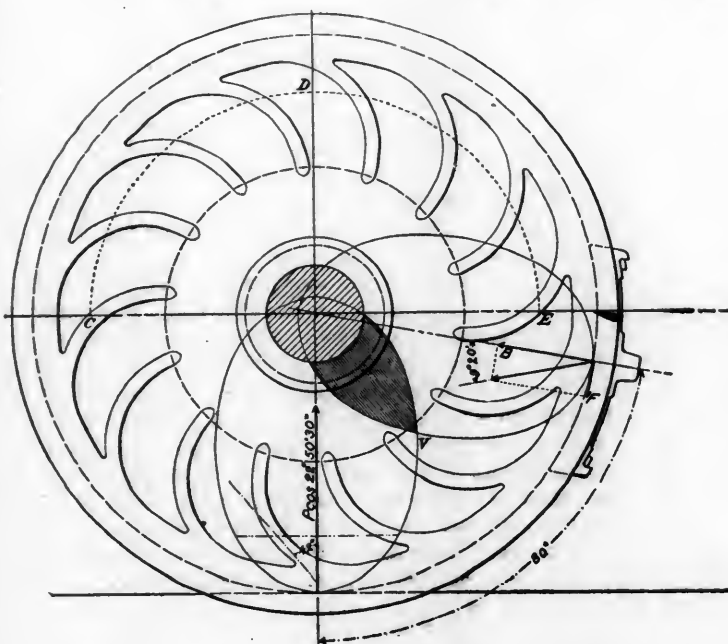


Fig. 2.

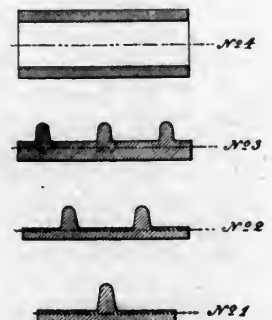
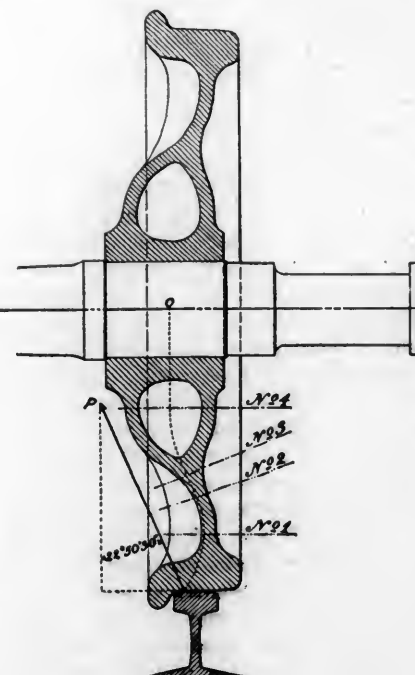


Fig. 3.

feet radius, the centrifugal force C of this car would be equal to 23,570 pounds, and the resultant of this force and the weight W would make a total of 100,800 pounds. If this is divided into two components, one through each rail-head, the pressure P on the outside rail would be 82,054 pounds, acting at an angle of 22 degrees, 50 minutes and 30 seconds with the vertical. The reaction on each wheel, also marked P in Fig. 2, is then equal to 20,514 pounds. The component P_1 , acting on the inside rail, being only 6,463 pounds per wheel, will not be further considered. The force P is transmitted to the axle partly by the metal located between the rail and the wheel-fit, which is thus under compression, and partly through the rim to the diametrically opposite portion of the wheel, whereby a tension is caused in the plate between the rim and the hub, in the same manner as the spokes of a bicycle wheel are put in tension by the load at the center. The portion of the wheel under compression will be considered first. This portion does not include the whole lower half of the wheel, but only a section of it within a limited distance from the center line of strain, which connects the point of contact between wheel and rail with the center of the axle. The form of this section may be called a cycloidal sinoid, the absciss equation of the curve corresponding to the cycloid, while the ordinate equation is that of a sinoid, according to Reuleaux. The outline of this form, as shown in Fig. 2, is described by Redtenbacher's formula:

$$\frac{x}{l} = \frac{1}{\pi} \left(\arcsin \frac{y}{h} - \frac{y}{h} \sqrt{1 - \frac{y^2}{h^2}} \right),$$

where it should be observed that the diameter of the wheel-fit must conform to y , in order to enclose all parts of the wheel under compression.

This cycloidal sinoid can now be considered as a column, secured at the upper end, and its strength is expressed by Gordon's modification of Hodgkinson's formula:

$$K = \frac{F \cdot S}{1 + 1.8 a \frac{l^2 \cdot F}{J}}$$

in which F represents the area of cross section, J the moment of inertia, l the length, S the stress per square inch, and " a " a constant relating to flexure, which, according to Wm. Kent's new hand book, may be assumed as one sixty-four hundredth for cast iron.

In order to find the value of K four cross sections of the column have been selected at different places, as marked in the sectional view of Fig. 2. These cross sections are also shown in plan in Fig. 3. It will be noticed that the number of ribs falling within the cycloidal sinoid varies in the first three sections, and that section No. 4 is taken through the double plate. The type of wheel illustrated in Fig. 2 is the Pennsylvania Railroad 1895 model, which is the standard for 60,000 pound cars on a number of roads. The curvature of the brackets on this wheel is very marked for section No. 1, a tangent drawn through the section-plane making an angle of 42 deg. with the vertical. The bracket makes up 79 per cent. of the cross section area, and for this section K must therefore be substituted with $0.21K \times 0.79K \sec. 42 \text{ deg.}$

It will also be observed that if another cycloidal sinoid is described for the brake shoe pressure, it will overlap the one for the rail-reaction, as indicated by the shaded surface in Fig. 2. The inclination of the section-lines also shows the resultant direction of the rail-reaction and the brake shoe pressure combined, and this resultant must be considered in connection with section No. 4. The brake shoe pressure marked B in Fig. 2, being 70 per cent. of the light weight, is equal to 8,75 pounds, and its direction is assumed to be 80 deg. from the vertical. The coefficient of friction at 60 miles per hour, is not more than 16 per cent. (report of M. C. B. committee on laboratory test), which makes the frictional resistance $F = 1,372$ pounds. This and the brake shoe pressure result in a force of 8,684 pounds, deflecting 9 deg., 20 min. from the latter, or 49 deg., 20 min. from a line drawn from the center of the wheel to the point V , where the two curves intersect in Fig. 2. The cosine of this force for 49 deg., 20 min. added to the cosine of K for a 40 deg. angle,

will therefore take the place of K in Gordon's formula for section No. 4.

As the column is not loaded squarely, however, but at the angle of 22 deg., 50 min. and 30 sec., the formula must be further modified in order to cover the direct compression as well as the bending strain. If the load of the column is called L , K becomes equal to $L \cos. 22 \text{ deg., } 50 \text{ min., } 30 \text{ sec.}$, which represents the compression, while $L \sin 22 \text{ deg., } 50 \text{ min., } 30 \text{ sec.}$ stands for the bending component. Let v signify the angle, and the formula will appear thus:

For section No. 1:

$$L (0.21 + 0.79 \sec. 42 \text{ deg.}) = \frac{S \cdot F}{\cos. v \left(1 + 1.8 a \frac{l^2 \cdot F}{J} \right) + \frac{F}{Z} l \sin v}$$

For sections Nos. 2 and 3:

$$L = \frac{S \cdot F}{\cos. v \left(1 + 1.8 a \frac{l^2 \cdot F}{J} \right) + \frac{F}{Z} l \sin v.}$$

For section No. 4:

$$\left(L \cos. v \cos. 40 \text{ deg.} + 8684 \cos. 49 \text{ deg. } 20 \text{ min.} \right) \left(1 + 1.8 a \frac{l^2 \cdot F}{J} \right) \frac{F \cdot l}{Z} L \sin. v = S \cdot F.$$

It should be stated here, that as v signifies the angle which the direction of the force forms with the neutral plane at each section, and as at sections Nos. 2 and 3 the neutral plane recedes from the vertical, its angle of deflection must be deducted from v . For section No. 2: $v = 18 \text{ deg., } 30 \text{ min.}$, and for section No. 3: $v = 21 \text{ deg., } 45 \text{ min.}$, will therefore be used in place of v alone. The neutral plane is shown in the sectional view of Fig. 2 as a dotted curve extending from point O on the center line to the point of rail-contact.

The length l is measured perpendicularly to each section plane from the point of rail-contact. By inserting the values of F , J and Z for each separate section in the formula applying to the same, L can now be obtained for each of the sections. It will be found that its lowest value is for section No. 1, where $L = 0.7842 \dots S$.

As before stated, S represents the stress per square inch, and, if J and Z have been calculated for the portion of the column located to the left of the neutral plane in Fig. 2, this stress denotes the compression wholly. According to tests made a few years ago by Prof. Thurston, the ultimate resistance to compression is as high as 127,300 pounds per square inch for Salisbury car wheel iron; but for the purpose of this calculation it is assumed to be 120,000 pounds. If the force is applied suddenly, 28 per cent. of this, or 33,600 pounds, is, according to Nyström, all that can be counted on. Allowing now a factor of safety of 4, the safe compression stress in the wheel would be 8,400 pounds per square inch. If this value is inserted for S in the above expression, L becomes equal to 6,088 pounds, or in other words, the cycloidal sinoid of the wheel can safely stand a suddenly applied force of that magnitude, acting at an angle of 22 deg., 50 min., 30 sec. from the vertical.

Another force Q (see Fig. 4), at a certain angle w , may be substituted for L , as long as the sum of the horizontal and vertical components of each is the same, or: $L \sin. v + L \cos. v = Q \sin. w + Q \cos. w$. If w is chosen sufficiently large to make $Q \sin. w$ coincide with the rail-reaction's horizontal component $P \sin. v$, the latter can be substituted for the former in the above equation, from which then the value of $Q \cos. w = 131$ pounds can be obtained. Subtract this from $P \cos. v$ or 18,615 pounds, and the remaining 18,484 pounds are the part of the rail-reaction which, being transmitted through the rim to the upper half of the wheel, causes a tension in the plate.

Before proceeding further the ability of the rim to transmit this stress will be ascertained. For this purpose the following empirical formula is used:

$$M = 6,600,000 \cdot b \frac{(t - c)^2}{r^3}$$

in which b , t and r represent the dimensions indicated in Fig.

5; c is a constant which Nystrom gives as $\frac{1}{2}$ for cast iron; and M is the ultimate sustaining strength against collapse of one-half of the rim. By solving the equation M is found to be 544,500 pounds, which is more than sufficient for the purpose.

Returning, therefore, to the tension in the upper portion of the wheel, attention is now called to the generated forces which augment the stress caused by the rail-reaction. These are the centrifugal force of the wheel, and the strain caused by the expansion of the rim due to the heat produced by the brake shoe friction. Still another strain, induced by pressing the wheel on the axle, must also be considered. The latter strain, together with that due to the centrifugal force, tend to burst the wheel along its diameter, while the tension caused by the rail-reaction, the expansion by heat and the centrifugal force aim to produce rupture along the semi-circular section indicated by the dotted line CDE in Fig 2, where the plate is weakest.

The total centrifugal force of a 595 lbs. wheel at a speed of 60 miles per hour is equal to 80,474 pounds, if the square of the radius of gyration is 0.6 of the square of the radius of the wheel, as stated by Mr. R. A. Parke (N. Y. R. R. Club Proc., Nov., 1897). The bursting strain caused by pressing the wheel on the axle with a force of 30 tons, would, with a coefficient of friction of 0.2, come close to 300,000 pounds, according to recent experiments at the Alabama Polytechnic Institute by Prof. Wilmore, although earlier tests by Lucien Arbel put it considerably lower. The sum of this bursting strain and the centrifugal force, divided by π , represents a force of 121,220 pounds, which tends to burst the wheel in two along its diameter. The cross section area along this line is found, according to Guldin's law, to be 64.88 square inches for a 595 pounds wheel, if the specific gravity of the iron is $7\frac{1}{4}$. The strain per square inch of section is thus equal to 1,868 pounds.

Considering now the stresses which tend to rupture the plate of the wheel along the line CDE in Fig. 2, there is first the tension of 18,484 pounds due to the load. As before stated, this may be of the nature of a suddenly applied force, and the fiber strain caused by it is therefore from 1.6 to 2 times greater (Nystrom). Selecting the latter figure, we have then a tension of 36,968 pounds, which will cause a radial stress of four times as much or 147,872 pounds (Rankine). Next there is the centrifugal force of the metal lying outside the line CDE . Assuming this line to be at a distance of $13\frac{1}{2}$ inches from the center, the centrifugal force of the mass will be 24,693 pounds. Finally we have the strain due to the sudden expansion of the rim on account of the generated heat. Assuming an extreme difference of 300 degrees Fahr. in the temperature of the rim and of the plate inside section CDE , a modulus of elasticity of 17,000,000 a co-efficient of expansion of 0.0000062, and inserting these values in the following equation:

$$H = A \times 0.0000062 \times 300 \times 17,000,000,$$

in which A represents the cross section of the rim, we get $H = 347,160$ pounds. Referring now to Fig. 6, and considering the rim as a polygon composed of a number of surfaces one inch in length, each one of these would increase to 1.0000062 for each degree of temperature, causing a radial strain T in the plate. The size of T is found thus:

$$H : T = 1.0000062 : \sqrt{1.0000062^2 - 1},$$

which gives $T = 0.00346H$ for each inch of the circumference, or 25,500 pounds for the whole distance CDE .

Adding now the tension from the load, 147,872 pounds, the centrifugal force, 24,693 pounds, and the expansion strain, 25,500 pounds, we get 208,065 pounds as the total radial strain which tends to produce a rupture along the line CDE . The transverse area at this distance from the center is 44.26 square inches. The stress per square inch is therefore equal to 4,927 pounds, or about $2\frac{1}{2}$ times as much as in the diametrical section calculated before. As the sectional area through the line CDE also cuts through the brackets, which at that plane incline 42 deg., the stress per square inch of metal in the brackets is proportional to the secant of the angle, thus bringing it up to 6,631 pounds. If the tensile strength of the iron is 22,000 pounds, we have therefore a factor of safety of only $3\frac{1}{3}$ in the

brackets. In order to get the same safety in tension as in compression, iron with a tensile strength of 26,524 pounds would be required. As that is more than can be expected from the common grades of car wheel iron, the brackets in the wheel are the weakest places and will fail oftener than other parts.

Fig. 7 shows the standard Union Pacific wheel. It will be noticed that the tangent to a bracket at the dangerous section forms here an angle of only 26 deg. with the radius, which makes the secant of the tension in the bracket considerably less than in the previous example, bringing it down to 5,474 pounds, a factor of safety of 4. This points to the advisability of avoiding unnecessary curvature of the brackets.

It is interesting to note that if the method used in the above calculations for finding the stress due to the expansion of the rim by heating be applied to the thermal test of the wheel, it will be found that a difference of 2,448 deg. Fahr., between the temperature of the rim and that of the adjoining plate, is necessary to produce the same stress of 4,927 lbs per square inch as that caused by the assumed conditions of service used in these calculations. The average melting point for gray iron is, according to Greenwood, 3182 deg. Fahr., which leaves a margin of 734 deg. for the temperature of the plate, and also for the difference in temperature between the molten metal and the rim itself.

On many roads it is the custom to allow wheels with cracked brackets to remain in service. The analysis shows that this is not a safe policy, unless temporary limits are established for the load and the speed. If the brakes are cut out on a car, one-eighth of the possible maximum tension is eliminated, and a proportionate number of cracked brackets will not therefore impair the safety of the wheel, unless they are bunched.

By observing the ratio in which the various stresses in the wheel affect its strength, the most economical wheel section for a 100,000 pounds car may be developed, and it will also be seen how a wheel might be proportioned for the special purpose of withstanding the thermal test, regardless of service conditions.

In conclusion it should be said, that nothing new is claimed in this method of analyzing the stresses in a wheel; it merely represents a consecutive application of well known formulas, as in designing other mechanical constructions.

INCREASED CAPACITY OF THE PRESSED STEEL CAR COMPANY'S WORKS.

A recent Associated Press dispatch from Chicago stated that a new steel car plant was to be established in or near that city. This probably originated from the fact that the Pressed Steel Car Company is to greatly enlarge its plant at Joliet, Ill. A large tract of land has been purchased at Joliet, and the old Fox plant, now the western plant of the Pressed Steel Car Company, is to be enlarged to at least three times its present capacity. Ground has already been broken at Joliet, and the work will be pushed with the vigor characteristic of the company. When completed, the enlarged plant will have a capacity of 30 pressed-steel cars a day, in addition to a proportionate increase in the capacity for trucks, bolsters and other pressed steel parts. The total investment will aggregate \$500,000, and about 1,600 skilled workmen will be added to the force. With the Joliet plant complete, the capacity of the various works of the company will be in excess of 100 pressed-steel cars per day.

The rapid growth of the company is of considerable interest as well as importance. Within two years in Pittsburgh alone, the company has added 4,000 men to its force, and, as may be well understood, its pay roll has increased many thousands of dollars weekly. The new plant at McKee's Rocks, Pittsburgh, which alone will double the capacity of the Pittsburgh plants, called for an investment of over one million dollars. This plant will be in operation in July and will have a capacity of 40 pressed-steel cars, in addition to a large bolster and truck capacity. The Joliet plant was designed to take care of a share of the Western demand, which has increased so rapidly that the company has found extreme difficulty in caring for it. Since the first pressed-steel car was built, orders filled and unfilled aggregate about 15,000 cars.

PISTON VALVES FOR LOCOMOTIVES.

By F. M. Whyte,

Mechanical Engineer Chicago, & Northwestern Railway.

It was early appreciated that the main valves of locomotives ought to be so constructed as to be operative with as little strain as possible on the valve motion, and while it would appear that the use of what is termed the balancing on the usual form of the D slide valve has been more generally adopted in America, nevertheless, the importance of having a thoroughly balanced valve was understood in England and Europe years ago and efforts were made toward developing such valves. The familiar saying that "History repeats itself" is true when applied to locomotive engineering, and it is frequently remarked by old railroad men, that: "I saw something just like that when I was serving my apprenticeship," when their attention is called to something which is considered new at the present time. So it is with piston valves; it is extremely interesting to study the history of piston valves, and other designs made with the intention of decreasing valve friction, and to note that engineers of the present are learning some things about valves which were learned by the engineers of fifty or sixty years ago, and, while conceit may lead to the belief that much of the chaff has been discarded, it is quite possible that the engineers of a few years hence may find much that is now being overlooked. This, however, need not reflect on the present engineers, because development of other parts of the locomotive may make designs desirable which are not now suitable.

Among the early attempts to reduce the friction of valves may be mentioned that of Mr. John Hick; Hick placed rollers under the valves, the valves being carried on journals which were reduced below the diameter of the body of the rollers, the body of the rollers bearing directly on the valve seat. In 1859 Mr. Thos. Felton patented in England, and, in 1863, Capt. R. C. Bristol, of Chicago, patented in the United States, the idea of interposing the rollers immediately between the valve face and the valve seat, instead of carrying the valve on the journals of the rollers. Valves so supported were used in locomotive and marine service, and technical papers of that time report that valves so arranged gave much satisfaction, no difficulty being experienced in keeping the valves tight. There is nothing to indicate whether such reports emanated from disinterested or from interested persons, but the average railroad man of the present, guided by present demands and experience, would conclude that the reports were made by the former. Later, in 1868 and 1869, the Messrs. Sault, of New Haven, used rollers under valves, the rollers varying in diameter from 4 to 12 ins., depending on the size of the valves, and the use of such design in locomotive service was favorably reported.

The advantages which possibly may be obtained by the use of piston valves were early appreciated, and also the same difficulties which are experienced now with some designs of piston valves were met years ago and efforts were made to surmount them. These valves were called "equilibrium valves," and in some cases the very expressive adjective "perfect" immediately preceded the word "equilibrium." It is quite probable, however, that the fact, which is sometimes overlooked at present, the equilibrium of a piston valve may be very seriously affected by the use of packing rings, was understood, because means were provided for taking up wear; this might possibly indicate that the valve was made to fit closely in the casing, and this conclusion is strengthened by the direct statement made in literature of 1866 to 1869 to the effect that much difficulty was experienced by the unequal expansion of the piston valves and the cylinders in which they were placed. Apparently appreciating this difficulty, Mr. Thos. S. Davis, of Jersey City, designed in 1866, or immediately previous to that date, the valve and valve chest shown in Fig. 1; the valve casing, or cylinder in which the valve worked, was almost entirely surrounded with steam and the piston valve

could be adjusted to compensate for the wear. The valve was made long so that the passages between the steam chest and cylinder would be as short as possible. This was one of the early designs of valves which were claimed to be "perfect equilibrium valves," and it is believed that in this valve there were embodied the essential features of a successful "perfect equilibrium piston valve;" certainly there were in the mind of the designer those features which are now considered requisites, and his efforts were directed toward fulfilling them, whether he succeeded or not. The valve had no packing rings, but could be adjusted to compensate for wear; the valve casing, or cage, was so arranged that most of its outside surface was subjected to the temperature of the steam at boiler pressure; and the valve was of such length as to give the shortest ports possible.

This may be an appropriate place to declare the belief that a piston valve which is to fulfill the strongest claim made for such valves, that they are perfectly balanced, can not have the ordinary, nor many of the extraordinary, spring packing rings for making the valve tight, and an effort will be made later in this article to show what effect such rings, in some of the present designs of piston valves, have on the balancing feature. If this declaration is well founded, and it is demonstrated that the valve must be solid and without rings, then it follows that the valve must be a neat fit in the valve cage and the cage must expand and contract with the valve; this will require that the cage be subjected to about the same temperature as the valve, and that provision be made to allow free expansion and contraction of the cage.

In Fig. 2 another "equilibrium valve" is shown, which closely

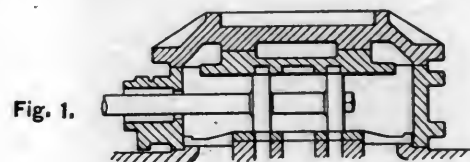


Fig. 1.

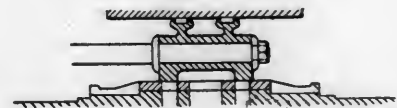


Fig. 2.

resembles an adaptation of the present common balancing plate and strips. The valve was designed by Mr. W. G. Beat- tie in 1867, or a short time previous, and was used on a locomotive on the London & Southwestern in 1868. Then, as now, experiments were made at as low cost as possible by first adapting new ideas to old equipment, and the illustration shows the valve as applied to a cylinder casting which was not designed specially for the valve. The valve was placed on a locomotive in January, 1868, and ran 16 months, making 61,147 miles, and showed so little wear that it was in condition to be placed directly in service again.

Apparently the adaptation of the piston valve to locomotives was neglected for a number of years, and the cause for such neglect is not apparent. It may have been considered that the benefits to be obtained were not commensurate with the inconvenience in changing designs of other parts, and of course this would be a more serious question at the present time. However, perhaps enough of history has been given to show that we are "threshing old straw," and it will be more to the point to show the results of the present threshing.

Until very recently it has been the general practice to use spring rings to make steam tight joints between the piston valve and its cage, or containing cylinder, and that such rings may fulfill the purpose for which they are intended it is necessary that they fit loosely between the metal forming the two sides of the grooves in which they are placed and the wearing action between the rubbing surfaces accompanied by the intended springing of the rings outward to compensate for the wear, soon leaves spaces back of the rings, even though the

rings, when new, may bottom in the groove. On account of the space required at the sides of the rings and behind them, it is very certain that the rings are pressed outward by the pressure of the steam in the steam chest, as well as by the springing action of the rings, and, indeed, this is very essential, because if this pressure back of the rings were not available, it would be necessary to make the rings sufficiently stiff to insure them against collapse while passing over the ports and when subjected, on their outer surfaces, to the live, or ex-

haust, steam pressure. Some piston valves are provided with narrow rings and, as far as the balancing is concerned, this is approaching the best theoretical condition, but other conditions have seemed to dictate the use of wider rings. If it is necessary for the rings to travel over the ports, as at present seems to be the case, then because of the necessary springing action of the rings, provided to keep them in contact with the casing, it is essential that bridges should be placed across the ports to carry the rings over; these bridges may be made as broad as convenient, but the same amount of wearing surface cannot be provided in them that is given in the other parts of the casing over which the rings travel; the result, therefore, is that the bridges wear faster than the continuous face of the casing, and in the course of time shoulders are formed over which the rings must travel. This condition prevailing, the ultimate result is that the rings will be broken, with more or less serious consequences, or the

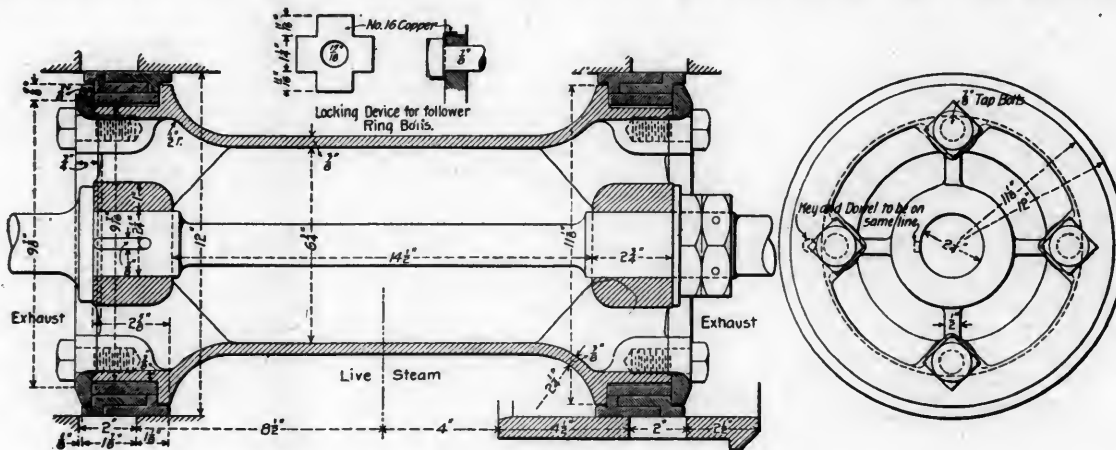


Fig. 3.

haust, steam pressure. Some piston valves are provided with narrow rings and, as far as the balancing is concerned, this is approaching the best theoretical condition, but other conditions have seemed to dictate the use of wider rings. If it is necessary for the rings to travel over the ports, as at present seems to be the case, then because of the necessary springing action of the rings, provided to keep them in contact with the casing, it is essential that bridges should be placed across the ports to carry the rings over; these bridges may be made as broad as convenient, but the same amount of wearing surface cannot be provided in them that is given in the other parts of the casing over which the rings travel; the result, therefore, is that the bridges wear faster than the continuous face of the casing, and in the course of time shoulders are formed over which the rings must travel. This condition prevailing, the ultimate result is that the rings will be broken, with more or less serious consequences, or the

valves at present in use are provided with narrow rings, the outer ones of which are set in from the ends of the valve, and these are reported by those interested in them to be working satisfactorily; but it is believed that practice, as far as the proper distribution of the steam and the providing of the necessary wearing surface are concerned, has shown the desirability of wide rings, whereas the question of properly balancing the valve will require narrow rings, the limiting point of the latter being the discarding of the rings entirely.

Having shown the causes which lead to the use of wide rings, it will be interesting to follow the effects of their use on the balancing of the valve. There is shown in Fig. 3 the section of a piston valve which has been used in a number of locomotives for both freight and passenger service, and which probably illustrates the extreme practice in the use of wide rings. When these valves first went into service it was reported that they were giving entire satisfaction and that the valves were

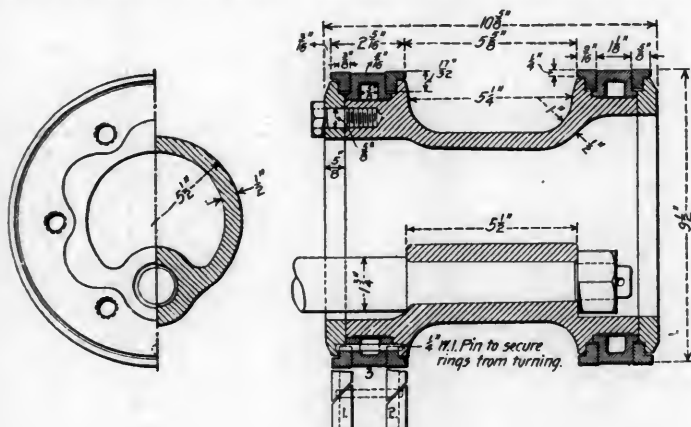


Fig. 4.

casing must be rebored. Efforts to overcome this difficulty have taken the direction of wider rings, and in some designs the rings are made wider than the ports over which they pass in order to insure that the rings cannot drop into the ports. Another reason for using wide rings is as follows: When the very narrow rings were first used it was considered that the ends of the valves were the controlling edges, but it was soon found that the edges of the rings were the controlling edges. It is necessary to have a shoulder at each end of the valve to

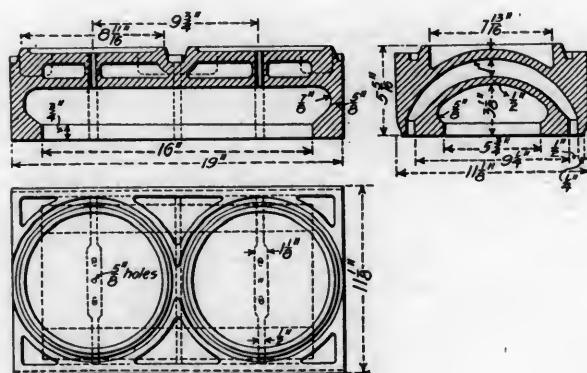


Fig. 5.

easily operated by the reverse lever, but changes made in the design to provide narrower rings, and reports that it required both engineer and fireman to reverse the engine under steam would indicate otherwise, and the table given below, showing the "load" on the valve, will explain the reason and also substantiate the position taken in this discussion.

Fig. 4 shows the development of moderately wide rings from the narrow rings; originally this valve had narrow rings set in from the ends of the valve, but when it was found that the

edges of the rings were the controlling edges the ends of the valve were beveled $\frac{3}{16}$ in., as shown, and the rings made L shape, so that the leg would extend to the ends of the valve. The result of this was an improvement in the admission of steam at the expense of the balancing of the valve, but that the latter effect was not serious is shown in the table below.

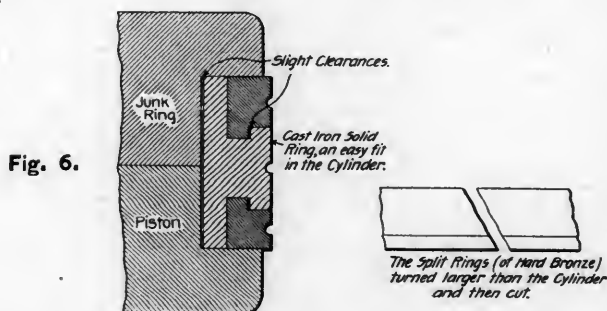
The number of piston valves is not limited to those shown in these engravings, but as it is the intention merely to call attention to the fact that because a valve is of the piston type does not insure that it is balanced thoroughly and that some piston valves are not as well balanced as the ordinary D valve can be. In Fig. 5 is shown the latter type of valve and the table gives data from which a better appreciation of the value of the balancing of the different types of valves may be obtained.

Location of valve.

	Total pressure forcing rings of valve against seat in pounds.; Valves shown in		
	FIG. 3.	FIG. 4.	FIG. 5.
Central (no steam in cylinder)...	32,504	6,460	16,160
Beginning of admission.....	22,894	2,356	9,960
$\frac{1}{4}$ Port opening.....	26,097	1,330	9,714
$\frac{1}{2}$ Port opening.....	29,301	1,330	9,478
$\frac{3}{4}$ Port opening.....	29,678	2,356	8,132
Full port opening.....	19,690	3,895	7,382
At cut off.....	32,504	2,356	16,106

The above figures allow for the steam pressure in the steam chest and the steam pressure in the cylinder after the first exhaust, except in first location, marked "Central."

That the use of packing rings on piston valves may seriously affect the balancing is more generally appreciated than it was



a year ago, and efforts have gone so far even as recent attempts to balance the packing rings on the main pistons, and some of the railroads have been approached by inventors who claim to have accomplished such a result; it is extremely doubtful, however, whether the rings can be balanced and fulfill their function regardless of some alleged tests to the contrary and patents issued covering the designs.

[We have taken the liberty to add Fig. 6 to the illustrations presented by Mr. Whyte in order to show a method of making piston packing rings devised by Sir John Durston, recently described in "Engineering." This ring is split and is restricted so that it can open only to a certain extent. The carrier is of cast-iron with two hard bronze rings having lips. A small clearance is allowed between the carrier and the rings, so that the latter may expand up to the clearance allowed. In working, this acts as an ordinary loose ring, but it soon begins to wear the cylinder, and this continues until a perfect fit is obtained. This arrangement is now fitted to all the auxiliary machines in the British navy. Piston valves are necessarily used in all auxiliaries owing to the high steam pressures, and this enhances the importance of a satisfactory piston ring.—Editor.]

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The 39th semi-annual meeting of the American Society of Mechanical Engineers, held May 9 to 12, in Washington, D. C., was a very successful one. The list of subjects was given last month, and of these the most important will be mentioned. The report of the Committee on the Revision of the Society Code of 1885 for a standard method of conducting boiler trials was presented in final form and is a very important document.

The paper on construction and material for pipe flanges brought out a lively discussion, which made it evident that this is a very important subject. Admiral Melville stated that in the war with Spain, steam pipe joints gave more trouble than any other factor about the ships. Mr. Henderson's excellent paper on the manufacture of car wheels was not discussed, because of the lack of members who were sufficiently informed. It was carried over for the next meeting, and it is hoped that it may then receive the attention it deserves. Mr. Henderson showed that this branch of manufacturing was now conducted upon a scientific basis of physical and chemical specification and test, and the desirable composition of wheels was given. The equipment of tall office buildings was an important subject, and the paper by Mr. Bolton gave satisfactory data to show the character and extent of the problems involved. Mr. John Fritz presented a paper describing successful fly wheel designs for rolling mill engines, which included fly wheels which have been running for 25 years without failure. The practice is a valuable precedent for future designers. Prof. Bull's paper on the central heating plant of the University of Wisconsin introduced the subject of central power stations, and the most significant fact brought out in the discussion was that concentration of power was not always advisable, especially when it involved the use of auxiliary elements scattered over a large area, such as pumps for the return of water of condensation. The use of coal handling machinery for comparatively small plants was considered unwise, because unnecessary. The extensive and admirable power plant of Columbia University was described in considerable detail by Mr. E. A. Darling, and the paper is a valuable document because of its completeness. Among the remaining papers the most interesting to our readers was that by Mr. Quereau on the Allen valve for locomotives. The paper states the merits of this valve and it also answers the few objections which have been raised to it. The value of the Allen port in securing good steam distribution was shown by indicator cards. The discussion offered by Mr. Charles T. Porter was chiefly historical. The valve was introduced in England in 1862, and later in this country. The credit for its adoption in general practice in this country was given to Mr. M. N. Forney. The Allen port and the Richardson balancing feature together had made this valve a success.

The desirability of inviting the management of the International Railway Congress to hold the meeting, next after the Paris meeting of 1900, in the United States, was suggested by Col. H. S. Haines before the New York Railroad Club at its May meeting. The idea is an excellent one and it will have the earnest support of all who are interested in bringing about a more perfect understanding among foreign railroad men of American transportation methods.

Gasoline engines have been selected as the most satisfactory source of power for removing the water of drainage from the depressed track work at 16th and Clark Streets in Chicago. The height of the Chicago River varies in such a way as to necessitate pumping the water when at the high levels and yet most of the time natural drainage may be relied upon. The drainage is all directed toward a sump, immediately over which two 8 horse-power Fairbanks-Morse gasoline engine are placed and coupled to centrifugal pumps, which are immersed in the sump. These pumps have a capacity of 2,250 gallons per minute and they are coupled direct to the engines by clutches, which may be thrown into gear after the engines are started. The application of gasoline engines to this service is admirable, because the demand is intermittent. The river is often low enough for several weeks at a time to permit of gravity drainage, and yet the pumping machinery must be ready for instant use when required. This requirement, as well as low cost of operation and small initial outlay required, seemed to be best fulfilled by the gasoline engine.

LOCOMOTIVE DESIGN.—THE WORKING STRENGTH OF MATERIALS.

By F. J. Cole, Mechanical Engineer, Rogers Locomotive Works.

BOILERS.

It is generally conceded at the present time that the normal stress for the plates composing the cylindrical portion, the shell top, dome, etc., in new steel locomotive boilers should be about one-fifth of the ultimate static strength, calculated at the longitudinal riveted joints, which are usually the weakest points. With a properly constructed butt joint, sextuple riveted with double cover strips, holes punched and reamed to size, 85 per cent. of the strength of the solid plate can be readily obtained. A working stress of one-fifth of the ultimate strength may safely be taken as representing good practice, better, no doubt, than the average, with some allowance for possible deterioration in time, caused by corrosion, pitting, grooving and other sources of weakness. It would also permit the pressure to be maintained at its maximum for a greater number of years than is usually possible. This is a point which should be carefully considered in building locomotive boilers, and a sufficient margin of strength allowed over and above the actual amount required when new, so that the maximum efficiency of the engine can be maintained by keeping the boiler pressure at the original figure for which the engine was designed, until the machinery is worn out or other reasons render its retirement from service desirable. An occasional renewal of the firebox flue sheets every few years, and the entire firebox at longer intervals, would be required, as the life of the sheets directly exposed to the fire is necessarily much shorter than that of the outside shell. Too much emphasis cannot be laid upon the fact that because a boiler is entirely safe when new, where the stress is considerably below one-fifth of its ultimate strength, yet in time, owing to corrosion, expansion and contraction, produced by variations in temperature and other weakening causes, the strength may be so reduced that what was originally a safe pressure soon may become a dangerous one. Another side of the case which deserves consideration is the question whether large and small boilers should be designed with the same working stress and the same factor of safety. Inasmuch as corrosion, taking the forms of grooving, pitting, or simply thinning the plate over large areas, is as active in a small boiler as a large one, it would seem a rational policy to design all boilers with a working stress of say one-fourth the ultimate bursting pressure, and then add a uniform amount, say, $\frac{1}{16}$ or $\frac{1}{8}$ inch extra thickness to the plates, to cover the injury caused by improper caulking, which may take place in building or afterward in repairs, the action of corrosive water, rust and other causes. Under these conditions, assuming that the elastic limit is not less than 55 per cent. of the ultimate strength of the plates, with longitudinal joints having an efficiency of 85 per cent., the factor of safety at the elastic limit would be 2.2 at the joint, exclusive of the extra thickness, and 2.6 at the solid plate, where it would be more likely to be attacked by corrosion, as the longitudinal joints are generally above the center of the boiler.

Under the rules of the United States Board of Supervising Inspectors of Steam Vessels, as amended January, 1899, the working stress for boilers built since 1872 is about 26.6 per cent. of the ultimate strength for double-riveted seams, and 27.7 per cent. for single-riveted seams, assuming that the longitudinal joints have an efficiency of 75 per cent. for the first and 60 per cent. in the second case. The rules are:

"Multiply one-sixth of the lowest tensile strength found stamped on any plate in the cylindrical shell by the thickness—expressed in inches or parts of an inch—of the thinnest plate in the same cylindrical shell, and divide by the radius or half diameter—also expressed in inches—and the sum will be the pressure allowable per square inch of surface for single riveting, to which add 20 per cent. for double riveting, when all

the rivet holes in the shell of such boilers have been 'fairly drilled' and no part of such hole has been punched.

"Where butt straps are used in the construction of marine boilers the straps for single butt strapping shall in no case be less than the thickness of the shell plates; and when double butt straps are used the thickness of each shall in no case be less than five-eighths of the thickness of the shell plates.

"The hydrostatic pressure applied must be in the proportion of 150 pounds to the square inch to 100 pounds to the square inch of the steam pressure allowed."

The working pressures obtained by means of the foregoing rules do not vary according to the strength or style of the joints, except as single or double riveted, nor do the rules provide what is considered at the present time a sufficient factor

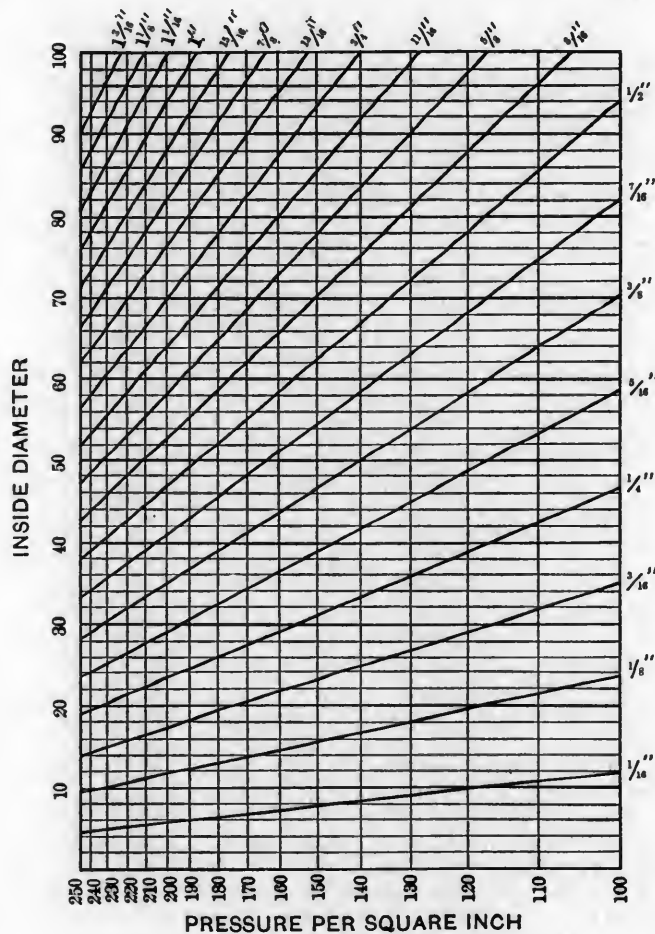


Fig. 1.

of safety for locomotive boilers working at high pressures. As the factor is only about 3.9 of the ultimate bursting pressure, the rules may be regarded as unsatisfactory and unsuitable for modern locomotive practice. In adjusting the pressures on boilers built several years ago which carry moderate pressures, they may be found useful.

In Lloyds rules (British) for the strength of cylindrical boiler shells the working pressure is calculated from the following formula:

$$\frac{C \times T \times B}{D} = \text{working pressure.}$$

Where C = coefficient as given in table below.
T = thickness of plate.

D = mean diameter of shell.

B = percentage of strength of joint found as follows, the least percentage to be taken:

$$\text{For plate at joint } B = \frac{P - d}{P} \times 100$$

$$B = \frac{n \times a}{P \times T} \times 85 \text{ with steel rivets in steel plates.}$$

$$B = \frac{n \times a}{P \times T} \times 70 \text{ with iron rivets in steel plates.}$$

(In case of rivets being in double shear, 1.75 a is to be used instead of a) where P = pitch of rivets; d = diameter of rivets; a = sectional area of rivets; n = number of rows of rivets.

Coefficient "C" for Steel Boilers.

Description of longitudinal joint.	For plates $\frac{1}{2}$ inch thick and under.	For plates $\frac{3}{4}$ inch thick and above $\frac{1}{2}$ inch.	For plates $\frac{1}{2}$ inch thick and above $\frac{1}{2}$ inch.	For plates above $\frac{1}{2}$ inch thick.
Lap joints	200	215	230	240
Double butt strap joints.....	215	230	250	260

This is based broadly upon a factor of safety of five with certain limitations and additions. The working stress per square inch of section is as follows:

Iron Boilers.

	Plates $\frac{1}{2}$ -in. and less.	Plates $\frac{3}{4}$ -in. and above $\frac{1}{2}$ -in.	Plates over $\frac{1}{2}$ -in.
Lap joint, punched holes.....	7,750	8,250	8,500
Lap joint, drilled holes.....	8,500	9,000	9,500
Double butt strap joint, punched holes...	8,500	9,000	9,500
Double butt strap joint, drilled holes.....	9,000	9,500	10,000

Steel Boilers.

	Plates $\frac{1}{2}$ in. and under.	Plates $\frac{3}{4}$ in. and above $\frac{1}{2}$ in.	Plates over $\frac{1}{2}$ in.
Lap joints	10,000	10,450	11,500
Double butt strap joints.....	10,450	11,500	12,500

The following extract from a useful little table printed under the caption, "Safe Working Pressures for New Boilers," in "The Locomotive," a paper published under the auspices of The Hartford Steam Boiler Inspection Co., is worthy of record:

"The following short table, which we use in our own practice in fixing the working pressure of new boilers, may be of use to our readers. The pressures given by the table are not as high as are allowed by the rules of the United States Board of Supervising Inspectors, but those, in our opinion, are somewhat greater than can be safely carried after a boiler has been in use for some time."

Steel of 60,000 Pounds per Square Inch of Section.

Thickness of plates.	Diam. of rivets.	Pitch double riveting.	Safe working pressure in pounds per square inch for shells with longitudinal seams double riveted.
$\frac{1}{4}$	$\frac{1}{2}$	36 Diam.	135
$\frac{3}{8}$	$\frac{3}{4}$	42 Diam.	115
$\frac{1}{2}$	$\frac{1}{2}$	48 Diam.	100
$\frac{3}{4}$	$\frac{3}{4}$	54 Diam.	85
$\frac{1}{2}$	$\frac{1}{2}$	60 Diam.	95
$\frac{3}{4}$	$\frac{3}{4}$	66 Diam.	100
$\frac{1}{2}$	$\frac{1}{2}$	72 Diam.	110
$\frac{3}{4}$	$\frac{3}{4}$		125
$\frac{1}{2}$	$\frac{1}{2}$		135

[For thicker plates the pressures can be obtained approximately by simple proportion.—F. J. Cole.]

The Hartford Steam Boiler Inspection Co. says: "We consider 5 to be the best factor of safety when all things are considered, though we sometimes allow $4\frac{1}{2}$ when the workmanship is known to be first class, and the materials of which the boiler is made have been carefully selected and tested."

Nominal Factors of Safety.

Lloyds (British), about 4.5 to 5.5.

Board of Trade (British), 4.5 for best construction and workmanship.

German Lloyds, 5 to 4.65, according to thickness of plates.

Laws of City of Philadelphia, 5.

The strength, thickness of plates and working pressure for circular boiler shells may be determined by the following formulae:

Let t = thickness of plates.
 P = pressure per square inch.
 F = factor of safety.
 D = inside diameter.
 J = percentage of strength of joint to solid plate.

S = lowest tensile strength of plates per square inch.
 M = stress per square inch.

$$\text{Then } t = \frac{D P F}{2 S J} = \frac{D P}{2 M J}$$

$$P = \frac{S t 2 J}{D F} = \frac{M 2 J t}{D}$$

$$F = \frac{S t 2 J}{D P} \quad M = \frac{P D}{2 t J}$$

The value of S and t combined may be taken directly from Table No. 1.

Example: A boiler, 65 inches greatest inside diameter, steam pressure 200 pounds per square inch; joint efficiency 85 per cent. of solid plate; lowest tensile strength of plate 55,000 pounds; factor of safety 5; required the thickness of plates.

$$t = \frac{D P F}{2 S J} = \frac{65 \times 200 \times 5}{2 \times 55000 \times .85} = \frac{6500}{9350} = .695 \text{ or about } \frac{11}{16} \text{ inch.}$$

TABLE NO. 1.

Strength of Steel Boiler Plates, 1 Inch Wide.

Thickness.	Tensile strength.		
	50,000 lbs.	55,000 lbs.	60,000 lbs.
$\frac{1}{4}$	12,500	13,750	15,000
$\frac{3}{8}$	14,062	15,469	16,895
$\frac{1}{2}$	15,625	17,188	18,750
$\frac{5}{8}$	17,187	18,907	20,625
$\frac{3}{4}$	18,750	20,625	22,500
$\frac{7}{8}$	20,312	22,344	24,375
1	21,875	24,063	26,250
$1\frac{1}{8}$	23,437	25,782	28,125
$1\frac{1}{4}$	25,000	27,500	30,000
$1\frac{3}{8}$	26,562	29,219	31,875
$1\frac{1}{2}$	28,125	30,938	33,750
$1\frac{5}{8}$	29,687	32,657	35,625
$1\frac{3}{4}$	31,250	34,375	37,500
$1\frac{7}{8}$	32,812	36,094	39,375
2	34,375	37,813	41,250
$2\frac{1}{8}$	35,937	39,532	43,125
$2\frac{1}{4}$	37,500	41,250	45,000
$2\frac{3}{8}$	39,062	42,969	46,875
$2\frac{1}{2}$	40,625	44,687	48,750
$2\frac{5}{8}$	42,187	46,406	50,625
$2\frac{3}{4}$	43,750	48,125	52,500
$2\frac{7}{8}$	45,312	49,844	54,375
3	46,875	51,562	56,250
$3\frac{1}{8}$	48,437	53,281	58,125
$3\frac{1}{4}$	50,000	55,000	60,000

pressure (otherwise the same as the preceding example).

$$P = \frac{S 2 J t}{D F} = \frac{55000 \times 2 \times .85 \times .695}{65 \times 5} = 200 \text{ lbs.}$$

By means of diagram Fig. 1 the proper thickness of plates for pressures from 100 to 250 pounds and sizes of boilers up to 100 inches diameter may be obtained without any calculation.

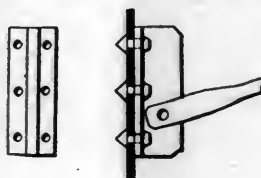


Fig. 2.

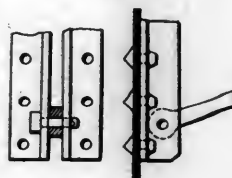


Fig. 4.

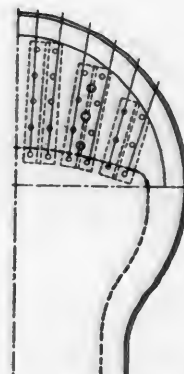


Fig. 3

It is based upon a factor of 5, or upon a stress of 11,000 pounds per square inch, assuming the minimum ultimate tensile strength of the plates to be 55,000 pounds and the joint efficiency 85 per cent. Example: What thickness of plate is required for a boiler 70 inches inside diameter, working pressure 200 pounds. Follow the horizontal line marked 70 until it intersects the vertical line marked 200, the diagonal line marked $\frac{3}{4}$ at the intersection is the thickness required.

TABLE NO. 2.
Boiler Steel.

Name.	Kind.	Desired.		Length of spec.	Will reject.		Chemistry.																		
					Tensile strength .			Carbon.			Phos.			Man.			Sil.			Sul.			Cop.		
		Tensile strength	Elongat'n		Max.	Min.	Elongation.	Desired.	Max.		Desired.	Max.		Desired.	Max.		Desired.	Max.		Desired.	Max.		Desired.	Max.	
									Min.	Min.		Min.	Min.		Min.	Min.		Min.	Min.		Min.	Min.			
Master Mechanics' Association...	Shell	60,000	25%	8"	65,000	55,000	20																		
	Firebox	60,000	28	8"	65,000	55,000	22	.18	.25	.15	.03	.035		.4	.45		.02	.03		.02	.035				
Penna R R Co., 1892	Shell	60,000	25	8"	65,000	55,000	20																		
	Firebox	60,000	28	8"	65,000	55,000	22	.18	.25	.15	.03	.04		.4	.55		.02	.04		.02	.05		.03	.05	
Erie R. R.	Shell	60,000	25	8"	65,000	55,000	20																		
	Firebox	60,000	28	8"	65,000	55,000	22																		
C. B. Q. R. R. Co.	Shell	60,000	28	8"	65,000	55,000	22	.18	.25	.15	.03	.035		.4	.45		.02	.03		.02	.035				
	Firebox	60,000	28	8"	65,000	55,000	22	.18	.25	.15	.03	.035		.4	.45		.02	.03		.02	.035				
Baldwin Locomotive Works.	Shell	60,000	25	8"	65,000	55,000	20		.25	.15		.05			.45			.03			.05				
	Firebox	60,000	25	8"	65,000	55,000	20		.25	.15		.03			.45			.03			.035				
Rogers Locomotive Co.	Shell	60,000	25	8"	65,000	55,000	20																		
	Firebox	54,000	28	8"	58,000	50,000	22	.18	.25	.15	.03	.035		.40	.45		.02	.03		.02	.035				
United States Navy.	Shell			8"	67,000	58,000	25					.035									.04				
	Firebox			8"	58,000	50,000	26					.035									.04				
British Admiralty.				8"	67,200	58,240	20																		
	Shell			8"	63,000	57,000	25																		
U. S. Navy, cruisers, 1887.				8"	55,000	50,000	29																		
	Firebox			8"																					

Table No. 2 gives the physical and chemical requirements of a number of specifications for boiler shell and firebox steel. It includes those of a number of prominent railroads, including those of the American Railway Master Mechanics' Association, the United States Navy, etc. With the exception of the British Admiralty and the United States Navy, the minimum tensile strength specified for flange or shell steel is 55,000 pounds per square inch. A working stress of 11,000 pounds for a factor of 5 and of 12,220 pounds for a factor of 4.5 seems most suitable for average conditions.

Heavy steel tees are generally riveted to the flat surface of the front and back heads, to which braces are secured. The usual method is shown in Figure 2, where the brace terminates in a jaw and is secured to the tee by means of a bolt and nut. The diameter of these bolts suitable for different sizes of braces calculated for a single shearing stress of 7,500 pounds

ing the braces to the boiler shell in small corners where there is not sufficient room for the tee iron.

The braces used for strengthening the flat surfaces, such as the upper parts of the back and front heads, should be designed for a working stress of 8,000 to 9,000 pounds per square inch. The stiffness of the head itself should be disregarded and the braces proportioned to carry the entire load. The area to be supported should be taken at 2 inches from the center of the top row of staybolts, Figure 5, or half their distance apart to the edge of the round corners, or to the center of radius of the corner.

The area to be braced, of the back head flat surface of a boiler having a flat crown sheet, is:

$$A = F^2 .7854 - (G F)$$

When A = area of flat surface requiring bracing.

B = radius of corner.

B = $\frac{1}{2}$ the distance apart of the staybolts.

S = maximum working steam pressure.

D = height of flat surface.

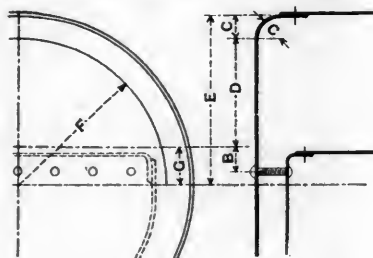


Fig. 5.

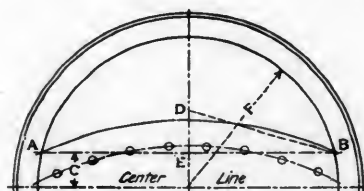


Fig. 6.

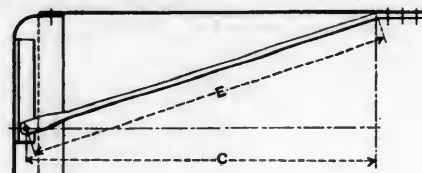


Fig. 7.

per square inch of area, and in double shear of $1.75 \times 7,500$ may be obtained from table No. 3.

TABLE NO. 3.

Diam. of brace.	Area.	Ultimate strength at 48,000 lbs.	Safe working stress.		Size and number of rivets in foot.	Size of foot.	Diam. of pins, double shear, 7500 x 1.15.
			8000	9000			
$\frac{3}{8}$ "	.60	23800	4800	5400	2 - $\frac{1}{2}$ " x 2"	$\frac{3}{8}$ "	$\frac{3}{8}$ "
$\frac{1}{2}$ "	.78	37500	6250	7020	2 - $\frac{3}{4}$ " x 2 $\frac{1}{4}$ "	$\frac{1}{2}$ "	$\frac{1}{2}$ "
$\frac{5}{8}$ "	.99	47500	7920	8910	2 - $\frac{3}{4}$ " x 2 $\frac{3}{4}$ "	$\frac{5}{8}$ "	$\frac{5}{8}$ "
$\frac{3}{4}$ "	1.22	58560	9760	10980	2 - $\frac{3}{4}$ " x 2 $\frac{3}{4}$ "	$\frac{3}{4}$ "	$\frac{3}{4}$ "
$\frac{7}{8}$ "	1.48	71040	11840	13320	2 - $\frac{7}{8}$ " x 2 $\frac{3}{4}$ "	$\frac{7}{8}$ "	$\frac{7}{8}$ "
$1\frac{1}{8}$ "	1.77	84960	14160	15930	2 - $1\frac{1}{8}$ " x 3"	$1\frac{1}{8}$ "	$1\frac{1}{8}$ "

The tees should not be less than 5 in. wide to allow room for the rivets and about 4 to 4 $\frac{1}{4}$ inches in depth. Figure 3 shows the usual arrangement of tees when used in radial stay boilers. In Belpaire and crown bar boilers the tees would be arranged vertically instead of radially. Heavy steel angles about 4x4 inches are often used in place of tees for attaching the ends of braces to flat sheets. They are placed back to back, with a sufficient space between to admit the ends of the braces as shown in Fig. 4, the ends being forged solid instead of using the jaw connection. The rivets should be about 4 to 4 $\frac{1}{2}$ inches apart lengthwise of the angles or tees, the usual diameters of the rivets being $\frac{3}{4}$, $\frac{7}{8}$ and 1 inch, varying according to the thickness of the plates and attachments.

Three-quarter inch rivets are used for plates not exceeding $\frac{3}{8}$ -inch; $\frac{7}{8}$ -inch rivets for plates from $\frac{7}{16}$ to $\frac{1}{2}$ -inch; and 1-inch rivets for plates $\frac{9}{16}$ -inch and over. Crowfeet, drop forged out of solid metal without welding, are used for attach-

E = radius of back head.

F = radius of flat surface.

G = center of staybolt to center of back head + B.

AS is the total force to be resisted by bracing.

$AS = \frac{AS}{8,000 \text{ to } 9,000}$ = the number of square inches of iron required in the braces.

When the crown sheet is curved for radial stay boilers, the area of the segment which requires bracing is shown in Figure 6. Draw the line, D B, so that equal areas will be left inside and outside the curved line. Then the area of the segment will equal one-half the area of the circle, having the radius, F, less the rectangle, 2 F C, and the triangle, D, E, B. If the braces are attached to the shell at a considerable angle, as in Figure 7, due allowance should be made. Counting the normal tension on the brace (if it were at right angles to the back

head) at 1, then the actual tension will = $\frac{E}{C}$.

Assuming that the minimum strength of the best wrought iron suitable for boiler bracing is 48,000 pounds per square inch, and that 37,500 pounds is the average resistance of rivet iron in single shears, then the factor of safety at 9,000 pounds is 5.33, and at 8,000 pounds it is 6. The rivets attaching the foot to the boiler shell may safely be proportioned for 7,500 pounds per square inch in single shear or a factor of 5.

A brace 1 inch diameter would have an ultimate breaking strength of 37,700 pounds, and a safe working strength of 6,250 to 7,020 pounds. It should be attached to the T iron, angle iron or foot by a pin not less than $\frac{7}{8}$ -inch diameter if in double shear, and by not less than 2 rivets driven in $\frac{13}{16}$ holes if in single shear. Table No. 3 will be found useful in proportioning the braces and pins.

SOME PRINCIPLES GOVERNING THE PROPER DISTRIBUTION OF LOCOMOTIVES IN ECONOMICAL RAILWAY OPERATION.

By E. M. Herr.

Like almost all important matters in railroad operation, the distribution of power requires the collaboration and close co-operation of several officers. The heads of both the mechanical and operating departments must frequently consult and supplement each other's knowledge before the distribution of power can be intelligently handled. When this is done, however, it is believed the proper officer to make the distribution is the head of the mechanical department, as it is easier for him to obtain exact information relative to the operating conditions than to give information as to mechanical questions, owing to their necessarily technical character.

The distribution as well as maintenance of locomotives being under the head of the mechanical department tends toward better maintenance and more satisfactory performance through less engine failures with their attendant expense and interference with successful and economical operation. In order to make the head of the mechanical department responsible for economical operation, as well as maintenance of locomotives, the cost of locomotive repairs should not be judged, as is usual, on the basis of the engine miles run only, but also and principally by the cost per ton-mile hauled. These statistics, if used to judge the economy with which locomotives are maintained, give the responsible mechanical officer an especial interest, as they should, in the real problem of economic railroad operation, the reduction of the cost per ton mile. The weight and horse-power capacity of locomotives used in main line service, provided the density of the traffic is the same, should be such as to enable if possible the same weight of train to be moved over the entire length of the line, thus avoiding the necessity of breaking up through trains at division points.

When the through trains are a large proportion of the total business on any division, the above distribution of power is undoubtedly the most economical. When, however, a considerable portion of the business originates and leaves a division at some point on it or at its terminus, thus making such business local thereto, heavier power than the above plan would call for can be advantageously assigned, owing to the possibility of increasing the average train load on such divisions with little or no increase in switching expense.

The number of locomotives to be assigned to any division is largely governed by the uniformity of the traffic movement. When this is about constant in volume in both directions, whether of equal volume or not, less power need be assigned than when the volume averages the same in each direction but varies considerably from day to day. In the latter case the surplus power is necessary to avoid running power light in one direction one day and perhaps in the opposite direction the next. When this condition prevails, however, a careful study of the situation must be made, as it may easily prove more economical to run power light occasionally than to decrease too much the average mileage made per locomotive by largely increasing the assignment of power. The character of the water supply may, if very bad, require a larger assignment of power due to an increase in boiler repairs and consequent laying up of power otherwise available.

The importance of a careful study of the actual conditions of traffic movement in order to intelligently distribute power cannot be too strongly emphasized. This pertains not only to a study of the local conditions of movement on each division, but what is still more important, an accurate knowledge of the periodic fluctuations of business on different parts of the system and a careful preparation for the prompt reassignment of power adapted to handle the increased traffic in one locality by moving such power from the place where business is decreasing. Such fluctuations occur on large railways in almost all parts of the country, and are generally due to the opening and close of navigation on lakes and rivers, the movement of a new harvest of grain, or fruit, etc.

On some roads a certain assignment of power is made to each division, which is supplemented in a haphazard way when the traffic is heaviest and is partly laid up when the movement is least. On many of our larger roads the heaviest traffic does not come on more than one part of the line at a time. It may be, for example, heavy on the northern or eastern divisions in the Spring and on the southern or western in the Fall. Such a condition gives an opportunity for economical operation by the prompt redistribution of power now not often fully utilized. It is, of course, common to send power from points where it is not needed to points where it is in demand, but generally without due regard to the type of locomotives best adapted to the service, on account of the reassignment having to be made hurriedly or without previous preparation.

The greatest economy of operation not only requires that sufficient locomotive power shall be available to meet the requirements of traffic on any division, but this power should also be the most efficient obtainable. Heavy locomotives, if available, should be moved from some distance, making them work their way in transit, if they can be used to advantage where power is needed, rather than transfer lighter power simply because it is perhaps on the adjoining division and convenient.

In assigning power, care must be used to discriminate between the power requirements of different divisions having perhaps the same ruling grades but different kind of grades or with the same degree and kind of grades with different conditions of operation.

On division A the grades may be short and constantly changing, giving the profile a sawtooth appearance. On division B the same steepness of grade may be practically continuous for long distances. Both these divisions having the same steepness of grade might at first thought be regarded as requiring the same kind of locomotives. The requirements are, in fact, quite different. As far as tractive power is concerned, the grades being equally steep the requirements are the same, calling for locomotives of equal weight and cylinder power. The difference comes in the requirement for boiler power or, what practically amounts to the same thing, the horse-power capacity of the locomotive. Locomotives were formerly built with more consideration for the mere weight and cylinder capacity or tractive power, and less for the boiler or steam generating capacity, than at present. Such locomotives are much better adapted to division A, and locomotives with larger boilers and better steam generating or horse-power capacity to division B.

In order to distribute power properly, it must be available when required. During seasons of light business, owing to an effort to keep the net earnings as uniform as possible, the shop and round-house forces are reduced or shorter hours worked, thus making it impossible to do work of repairs when locomotives can best be spared for shopping. This is generally short-sighted policy and poor economy. It also makes the intelligent and efficient distribution of power more difficult and often impossible, as the heavy first-class locomotives, instead of being shopped when least needed for work, are often kept out of the shops during the dull seasons on account of the decreased force being unable to turn as many of them out as of lighter engines and the immediate need being for more locomotives of any kind rather than more efficient locomotives.

For best economy the prevailing practice of reducing shop forces and expenses during periods of dull business should undoubtedly be reversed. The shops should be run full when business is light and locomotives available for shopping, and shop forces and expenses reduced when business is heavy and the power is needed in service.

Many mechanical officers will object to transferring power periodically, on account of the tendency to increase the cost of repairs, as locomotives are brought from the control of one master mechanic to that of another. This is largely, if not entirely, similar to the old argument that each engineer must run his own engine or repairs would be increased, and will soon be solved in the same way.

Good distribution of power will not alone accomplish the best

results; it must be accompanied and supplemented by good operation, both at the hands of the train-master, chief dispatcher and master mechanic also; but no amount of skill on the part of these officials will enable the most economical results to be obtained if the proper power is not available. For the proper distribution of power we therefore have the following:

Study carefully both grades and traffic conditions on each division.

Assign power so that traffic from one division to the next can be handled with the least switching.

Transfer power to meet periodic fluctuations in traffic by a well-developed plan, having due regard to doing the heavy repairs, as far as possible, during the dull season.

Assign locomotives of small boiler capacity to divisions having short grades or on which speed is slowest, other things being equal, and largest boiler and horse-power capacity locomotives on long, continuous grade divisions or where maintenance of speed is more important.

Co-operate heartily and confer frequently with officers of the operating department as to the requirements of the service and the conditions of traffic.

ECONOMICS OF FREIGHT LOCOMOTIVE OPERATION.

By G. R. Henderson.

Assistant Mechanical Engineer, Schenectady Locomotive Works.

In these days of railroad competition, no subject interests the operating departments as much as the economical handling of the freight traffic, especially upon roads where freight forms the larger part of the business. As the fuel bills of any large railroad are a very considerable proportion of its operating expenses, the relative consumption of coal per ton mile is considered of great importance, but there are often other factors of operation which quite overcome and sometimes reverse the final figures, when fully considered.

With the present tendency to load locomotives up to the maximum limit, managers are loath to believe that such a result is accompanied by an increased fuel consumption per ton-mile hauled back of the tender, and it will, perhaps, surprise some to know that under certain conditions the increase is very great.

In order to determine what this variation would amount to in actual practice, calculations were made on a locomotive of the consolidation type, with 20 by 24-inch cylinders, 150 lbs. boiler pressure, 50-inch drivers, and having a total weight of engine and tender of 105 tons. The heating surface was 1,774 square feet, and the grate area 31 square feet. The maximum cut-off permitted by the valve gear was 90 per cent. of the stroke, and as the most economical cut-off for a single expansion engine is at 25 or 30 per cent., deductions were made at 30, 60 and 90 per cent. cut-offs, at speeds of 5 and 10 miles per hour. As the boiler was not large enough to supply steam at the 90 per cent. cut-off at a higher speed than 10 miles per hour, the computations for 15 miles an hour were made for 30, 45 and 60 per cent. cut-offs. For each of the three speeds we have, therefore, determined the consumption of fuel at the

point of greatest fuel economy, the point of greatest power which the engine can exert at the given speed, and at a point intermediate between the two. The coal consumption for each point was calculated from the cylinder volume at point of cut-off, the cut-off pressure, mean effective pressure and weight of steam, allowing 25 per cent. for cylinder condensation at 30 per cent. cut-off, and 10 per cent. at 90 per cent. cut-off. The rate of combustion and corresponding rate of evaporation were also figured, and also the tractive power of the engine and the load which it would haul (back of tender) on a level, on a one per cent. grade and on a two per cent. grade. From these data the pounds of coal per 100-ton-miles were readily computed. The following table explains the method followed, giving the values at 10 miles per hour:

Data figured at.....	30	60	90 per ct. cut off.
Cylinder volume	1.3	2.6	3.9 cubic feet.
Cut-off pressure	106	114	136 lbs. per sq. in.
Mean effective pressure....	66	100	130 lbs. per sq. in.
Mean available pressure ...	61	92	120 lbs. per sq. in.
Weight per cu. ft. steam..	.275	.295	.340 lbs.
Allowance for condensation			
Steam used per hour.....	9,009	17,781	29,069 lbs. from and at 212°.
Available tractive force	11,712	17,664	23,040 lbs.
Coal burned per hour.....	900	2,223	4,457 lbs.
Rate of combustion.....	30	72	144 lbs. per sq. ft. grate.
Rate of combustion.....	.5	1.2	2.5 lbs. per sq. ft. H. S.
Evaporative rate	10	8	6.5 lbs. water per lb. coal from and at 212°.

Load Hauled, Gross.

On level (5½ lbs. resistance).....	2,135	3,205	4,180 tons.
On 1% grade (25½ lbs. resistance).....	460	692	903 tons.
On 2% grade (45½ lbs. resistance).....	257	388	505 tons.

Load Hauled, Net.

On level	2,030	3,100	4,075 tons.
On 1% grade	355	587	798 tons.
On 2% grade	152	283	400 tons.

Pounds Coal per 100 Ton-Miles, Net.

On level	5	7	11 lbs.
On 1% grade	25	38	56 lbs.
On 2% grade	59	79	112 lbs.

The various values given in the table were obtained by the method described in the "Report of Committee on Ratios of Grate Area, Heating Surface and Cylinder Volume" to the Master Mechanics' Association, 1897.

Diagram No. 1 shows graphically the results of calculations on this type of locomotive at speeds of 5, 10 and 15 miles per hour, and on levels 1 per cent., and 2 per cent. grades. The abscissae represent tons of train hauled (back of tender), and the ordinates the pounds of coal consumed per 100 ton-miles (also back of tender). The three small circles on each curve represent the points calculated at the different proportions of cut-off, corresponding to maximum load, most economical load, and an intermediate loading. The farthest point to the right is the greatest load which can be drawn by the engine under consideration (theoretically) on the grade and at the speed assumed.

This diagram shows that the most economical loading, as far as fuel alone is concerned, is that suited to the early cut-off, and that increasing the load means an increase in the amount of fuel per 100 ton-miles. On grades the variation is more striking than on levels. For instance, while on a level, at a speed of ten miles an hour, a load of 2,030 tons consumes 5 lbs. of coal per 100 ton-miles, and a load of 4,075 tons, 11 lbs. per 100 ton-miles, on a 2 per cent. grade, a load of 152 tons requires 59 lbs. of coal, and a load of 400 tons, 112 lbs. of coal per 100 ton-miles. These figures should not be confused and considered as merely the increase in consumption following an increase in the load, but it should be noted that the increase is in units of 100 ton-miles, or for the same amount of

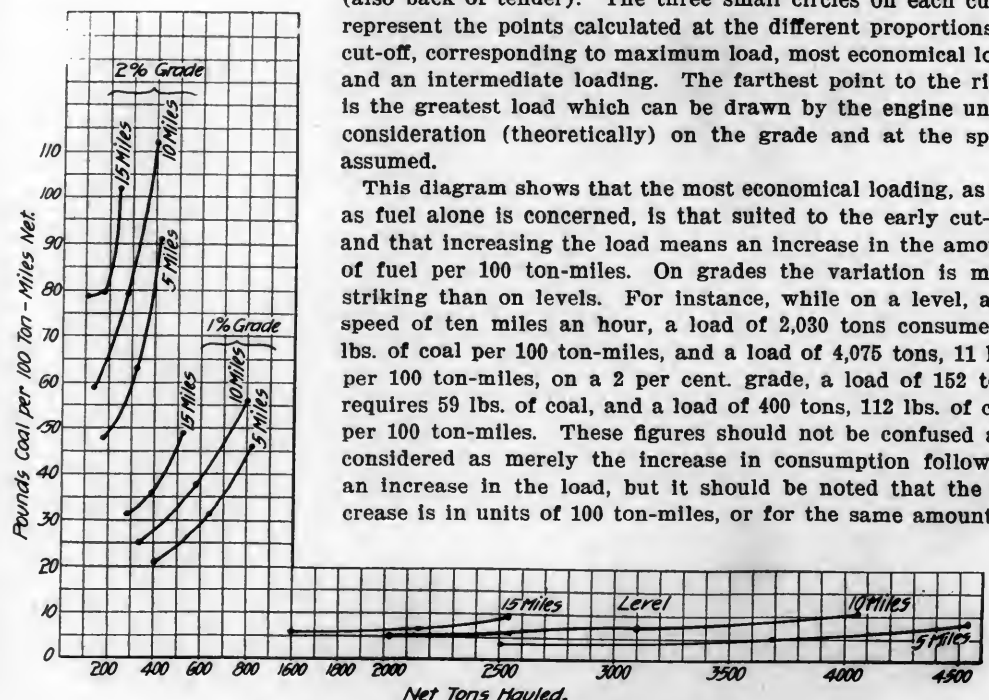


Fig. 1.—Coal Per 100 Ton Miles (Train Only).

work. This chart shows at a glance how unsatisfactory any comparisons of fuel consumption of locomotives are likely to be even on a ton-mile basis, except when the grade of the division and the working conditions are known and are subject to comparison. But, as above suggested, if the heavy train loads mean a loss in economy as far as fuel is concerned, it does not necessarily follow that the total cost of operation will be greater. In order to arrive at the total cost of train operation, as far as it is affected by the expenses directly chargeable to the individual trains, but not including maintenance of track, stations, signals, etc., which are approximately constant, regardless of the weight of trains, we will proceed further with our calculations, based upon the following items of expense:

Coal consumed	at \$1.00 per ton.
Locomotive repairs	at .05 per mile.
Locomotive lubrication	at .25 per hundred miles.
Sand, tools and supplies	at .13 per hundred miles.
Hostling, etc.	at .90 per hundred miles.
Engineman	at .40 per hour.
Fireman	at .20 per hour.
Conductor	at .30 per hour.
Brakeman	at .15 per hour.
Freight car repairs	at 2.60 per thousand car miles.
Freight car lubrication	at .05 per thousand car miles.
Assumed weight of each car loaded.	35 tons.

For interest and depreciation on the locomotive we allow as follows:

Depreciation at 10% on \$10,000	\$1,000 per year
Interest at 5% on \$10,000	500 per year
Total	\$1,500 per year

If we allow 300 working days in a year, we have $1,500 \div 300 = \$5.00$ per day of 24 hours, or, figuring on ten-hour runs, and two hours' lay over we have per trip \$2.50.

We can now figure the charges which are constant for a trip of 100 miles, or 10 hours, at 10 miles per hour, regardless of the train load, as shown below:

Locomotive repairs at \$.05 per mile	\$5.00
Locomotive lubrication at .25 per 100 miles .....	.25
Locomotive sand, tools and supplies at .13 per 100 miles .....	.13
Hostling, etc., at .90 per 100 miles .....	.90
Interest and depreciation for $\frac{1}{2}$ day	2.50
Wages of crew for 10 hours:	
Engineman ..	\$4.00
Fireman ..	2.00
Conductor ..	3.00
Two brakemen ..	3.00
Total constant charge	\$20.78

We may estimate freight car lubrication and repairs as follows:

Repairs per 1,000 car miles	\$2.60
Lubrication per 1,000 car miles .....	.05
Total per 1,000 car miles	\$2.65
Cost per car mile	\$0.00265

At assumed weight of loaded car, 35 tons, we have

Cost per ton-mile	\$0.000075
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We are now prepared to figure out the three points on each of the three curves for a speed of 10 miles per hour.

Train cost, at 10 miles per hour for a 10-hour run, or 100-mile trip, on a level:

Data	30	60	90 per ct. cut-off.
Hauling capacity (net)	2,030	3,100	4,075 tons.
Coal consumed	9,000	22,230	44,570 lbs.
Cost of coal at \$1 per ton	\$4.50	\$11.11	\$22.29
Constant charges	20.78	20.78	20.78
Freight car lubrication and repairs	15.22	23.21	30.50
Total cost	\$42.50	\$57.10	\$75.57
Cost per 100 ton-miles, net ..	2.00	1.78	1.81 cents.

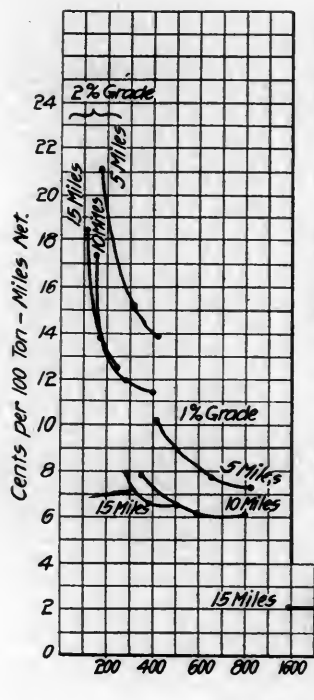


Fig. 2.—Cost Per 100 Ton Miles (Train Only).

The same on a 1% grade.

Hauling capacity (net)	355	587	798 tons.
Coal consumed	9,000	22,230	44,570 lbs.
Cost of coal at \$1	\$4.50	\$11.11	\$22.29
Constant charges	20.78	20.78	20.78
Freight car lubrication and repairs	2.66	4.40	5.98
Total cost	\$29.94	\$38.29	\$51.05
Cost per 100 ton-miles, net ..	7.88	6.20	6.15 cents.

The same on a 2% grade.

Hauling capacity (net)	152	283	400 tons.
Coal consumed	9,000	22,230	44,570 lbs.
Cost of coal at \$1	\$4.50	\$11.11	\$22.29
Constant charges	20.78	20.78	20.78
Freight car lubrication and repairs	1.14	2.12	3.00
Total cost	\$28.42	\$36.01	\$48.07
Cost per 100 ton-miles, net ..	17.38	12.00	11.52 cents.

This will indicate the method which was followed for each of the speeds considered, and the curves on Diagram on No. 2 were constructed in this manner, three points at each speed and for each grade having been calculated. The abscissae,

as in Diagram 1, represent the total load hauled back of the tender, while the ordinates indicate the cost in cents per 100 ton-miles. It will be seen at a glance that the total cost on the economical rate is entirely different from that due to coal consumption only. Of course this only holds strictly true for the prices and wages stated above, but the method of making the deductions would be the same, the different values being changed to suit the conditions being considered. The following remarks must not be understood, therefore, to apply only to such cases as may be covered by the figures assumed.

At a given speed the greatest economy is shown when the engine is loaded to the full limit of its capacity. This is illustrated by the fact that nearly all the curves have the lowest cost at a point agreeing with the maximum power of the engine, which is the right hand end of the various curves. This reverses the opinion formed by the coal consumption charge, and shows that the other features more than balance the loss in economy in the coal consumption.

The curves demonstrate that 10 miles per hour with the full load limit of the engine is about the cheapest speed at which to operate, this being particularly so on grades. Thus, on a 2 per cent. grade, we find that the engine, loaded to its maximum power, can haul freight at a cost of 11.52 cents per 100 ton-miles, whereas at 15 miles per hour the cost is 12.51 cents, and at 5 miles an hour, 13.84 cents per 100 ton-miles. On a 1 per cent. grade the difference is not so great, but is in the same direction. We would, therefore, conclude that for the conditions and prices assumed, 10 miles per hour is by far the most economical speed at which to operate freight trains on grades.

For a given load, 15 miles per hour is cheaper than 5 or 10 miles, and 10 miles is cheaper than 5 miles, which would indicate that if the engine is loaded to pass a 2 per cent. grade at 10 miles per hour, which, in this case, would mean a train load of 400 tons, on a 1 per cent. grade, it would be economical to increase the speed to 15 miles per hour, assuming that the load back of tender had remained constant.

On a given grade, we find that a very small reduction in the tonnage (when at the limit of power of the engine) allows the speed to be increased from 5 to 10 miles an hour, and at the same time effects a large reduction in the cost per 100 ton-miles. Take, for instance, at 5 miles per hour, where we find that the locomotive under consideration can haul 413 tons on a

2 per cent. grade, at a cost of 13.84 cents per 100 ton-miles. By reducing the load to 400 tons the speed can be increased to 10 miles per hour, and the cost of hauling will be only 12.52 cents per 100 ton-miles, or by decreasing the load about 4 per cent. we are not only able to double the speed, but also reduce the cost per 100 ton-miles about 15 per cent. The same facts hold good on a 1 per cent. grade in about the same proportion.

This is often overlooked in practical operation, but it has been exemplified in actual work, and goes to demonstrate that overloading to such an extent as to reduce the speed of the engine is not always an economical method of operation. A case known to the writer was that in reducing the load on a locomotive from 650 to 610 tons, the speed was increased from 5 to 10 miles per hour, reducing considerably the cost of operation. This must be understood, of course, as applying only to the maximum load at each speed, as a reduction of load without an increase in speed would cause additional expense, as illustrated by Diagram No. 2.

On a level section of track we find that there is practically no difference in the cost, no matter whether the speed be 5 or 15 miles per hour, or whether the engines be heavily or lightly loaded, as in this case the difference in coal consumption balances the other charges.

It would seem from the above that for the conditions assumed, 10 miles is the most economical speed at which to operate on parts of roads which are not level, but contain grades more or less heavy, but that on level stretches the speed can be varied without much effect on economy.

EXHAUST AND DRAFT APPLIANCES.

The subject of exhaust and draft appliances of locomotives, to be presented to the International Railway Congress at its Paris session next year, has been intrusted to Mr. C. H. Quereau, Master Mechanic of Denver & Rio Grande Railroad, as reporter. A circular of inquiry embracing an admirable series of questions for the purpose of bringing out information as to present practice has been received, and in view of the fact that this subject is of great importance and very little understood, it is to be hoped that the answers will be thoughtfully and carefully given. Notwithstanding the importance of correct design in the front end arrangements of locomotives, current practice shows widely different ideas, and it is evident that much may be learned by such a thorough discussion of the principles involved as is sure to be held at the meeting of the congress. It is learned from Mr. Quereau that 125 circulars have brought out but 20 replies, and when the advantages to be had from a thorough exposition of the reasons for the present diversity of opinion are appreciated the opportunity will be taken to assist the reporter to the utmost in representing American practice.

THE ATLANTIC TYPE AND THE WIDE FIREBOX.

By J. Snowden Bell.

It will no doubt be admitted, both by the designers and the builders of the two Atlantic type engines recently placed on the Chicago, Burlington & Quincy Railroad, and illustrated in the May issue of this Journal, that even if they shall, and it would seem probable that they will, fully and satisfactorily meet the conditions of exceptionally fast passenger service for which they have been constructed, it is within the possibilities that a still more effective performance might be attained by a modification of design which is not only fully applicable with the Atlantic type of engines, but it is also one with which that type would appear to have its most natural and logical application. The modification referred to is the employment

of a wide, instead of a narrow, firebox, and the purpose of the writer is not in anywise to disparage the design as executed, but to invite attention to the special capabilities and advantages of this type of engine, in connection with a firebox of the former class.

The evolution of the "Atlantic" type has not been by any means a gradual one, it being a direct development of the essential features of two classes of engines which preceded it, neither of which has gone into use to any considerable extent. The first of these classes, which afterward came to be known as the "Columbia" type, originated, some time prior to 1875, in the practice of the Grant Locomotive Works of Paterson, N. J., and is illustrated in Plate XVIII. of the first edition of Forney's Catechism of the Locomotive. The engine there shown weighed 52,000 pounds, with 42,000 pounds on two pairs of 56-inch driving wheels, a pair of leading wheels and a pair of trailing wheels, each 28 inches in diameter, and 14x22-inch cylinders. This class was revived, with the enlarged dimensions and improved detail of the then existing practice, shortly before the Chicago Exposition, in which two examples, one, No. 694, P. & R. R. with a wide firebox, and the other, the "Columbia," with a narrow firebox, were shown. The first of these was styled by the builders, "Double Ender" type, and the second, "Special High Speed" type, although each of these designations would seem as fully and appropriately applicable to one engine as to the other.

The second antecedent class in the general line of the Atlantic type, comprised, it is believed, only three engines, each having a four-wheeled leading truck, a single pair of driving wheels, and a pair of trailing wheels. All three engines had wide fireboxes, and they were understood to have been designed with the special purpose of admitting of the use of a firebox of this class with driving wheels whose diameter was too great to allow such a firebox to be placed above them. The first of these engines, which was built in 1880, by the Baldwin Locomotive Works, was an admitted failure and went early into the scrap pile; the other two, which were much later in date, are in service with satisfactory results on comparatively light trains. These engines accord in general design with the Atlantic type, differing in detail only in having one pair of driving wheels instead of two, and the Grant engines and their successors differ in having a two-wheeled instead of a four-wheeled leading truck. The support of an overhanging firebox upon trailing wheels is a salient feature which is common to all three of the classes referred to, and it is obvious that it is entirely independent of the number of driving and leading truck wheels.

The first Atlantic type engine that was built has a narrow firebox and this feature of design has been frequently reproduced, among others in the C. B. & Q. engines, which are probably the latest. It may therefore be assumed to be presented by the builders as representative and good practice. There has been more or less discussion of the relative merits of the Atlantic and of the ordinary ten-wheel type, that is to say, that having six driving wheels and a four-wheeled leading truck. Irrespective of the form of firebox applied in either case, but if the wide firebox be not employed, the object or reason of existence of the Atlantic type does not clearly appear, and it has not been made plain in any published statement within the knowledge of the writer. It will scarcely be contended, as a general principle, that the presence of trailing wheels is a desirable feature, particularly in an engine which is not intended to be run backward at speed, or that weight which is available for adhesion, (which, in the engines under consideration, is the substantial amount of 33,000 lbs.) should be transported as dead weight. Both these conditions are necessarily presented in the Atlantic type engine, and if a narrow firebox is used, are seemingly without any compensating advantage, either theoretical or practical. If, however, a wide firebox be employed, the Atlantic type is not only the ideal one for high speed service but is also apparently the only one in which practically any speed may be made and maintained which is per-

missible with present track, signal and brake facilities. With the application of the wide firebox, in connection with 84-inch, or larger driving wheels, the utility and necessity of the trailing wheels which characterize this type, are immediately and plainly apparent; the grate area and depth of firebox may be made as great as desired without interference with the driving wheels, and driving wheels of any desired diameter may be used without interference with the width and depth of the firebox. The sacrifice of the utilization of weight which is available for adhesion has its compensation, whether or not it be a sufficient one being, of course, a matter of opinion, in increased steam generating capacity and ability to employ lower grade and cheaper fuel. With the narrow firebox, the same sacrifice is made, in this type of engine, with no apparent compensation, and it is difficult to see why it should not be avoided by the substitution of a pair of driving wheels for the trailing wheels, which latter, though not desirable, may be tolerated when plainly advantageous, but should have no place in good practice unless their advantage is beyond reasonable doubt or question.

A number of Atlantic type engines have been constructed by the originators of the type, with wide fireboxes, and their performance in high speed service has been uniformly excellent and in some cases exceptionally so. Among these may be noted the Lehigh Valley engines running the Black Diamond Express, the C. R. R. of New Jersey on fast Royal Blue Line trains, and the Philadelphia & Reading engines on 50-minute trains from Camden to Atlantic City. It is, moreover, a matter of current report that wide firebox engines of this type are in preparation or under construction by the Pennsylvania R. R., and the adoption of this form of firebox by a system so conservative, and heretofore so pronounced in opposition to it, is strongly persuasive of its desirability in high speed service. All the wide firebox engines of this type which have been thus far built, as well as the majority of engines of other classes having this form of firebox, burn anthracite coal, for the successful use of which it has been recognized that a large grate area is practically indispensable, and we accordingly find 63.9 square feet of grate in the Lehigh Valley engines, and 76 square feet in the Jersey Central and Philadelphia & Reading.

It is unnecessary for present purposes, even if space permitted, to discuss the question of the relative merits and advantages of a large and a small grate, upon which much has been said and much remains to be said, more particularly in view of the results which may be reasonably expected in the performance of the new Pennsylvania engines referred to. It is, however, important to note that, doubtless by reason of the origin and general use of the wide firebox on roads employing anthracite coal as fuel, the impression seems to have been generally entertained that a wide firebox necessarily involves a material enlargement of grate area, and it is probable that this wholly unfounded assumption has contributed largely to the delay in the general introduction of the wide firebox into service with bituminous coal. It is obvious that a much smaller grate will be sufficient and proper with this class of fuel than with anthracite, and it is possible that, as has been contended by motive power officers whose opinions are entitled to respect, the area now employed in narrow fireboxes cannot be exceeded with economy or advantage. Be this as it may, the fact remains that a relatively long and narrow grate is, both in theory and in practice, inferior to one which approximates a square plan; the combustion in the latter can be effected more perfectly, and all parts can be reached by the fireman without the great and needless exertion which is involved in throwing coal to the forward portion of the long and narrow grates of present practice. While locomotive grates 10 to 12 feet long are fired every day and the engines taken over the road on time, it is manifest that the work required to do so is very much harder and more exhausting than would be the case if the same grate area was provided in shorter length and greater width. In the opinion of the writer, the special merit of the wide firebox lies not so much in the ability of obtaining an in-

creased grate area, as in that of disposing any desired and determined area of grate in a more advantageous and desirable form, that is to say, approximately square.

The fireboxes of the C. B. & Q. engines are stated to be 10 feet long by 40 $\frac{1}{2}$ inches wide, and the grate area as 33.6 square feet. The fireboxes of the Lehigh Valley engines are 9 feet 6 $\frac{1}{2}$ inches long by 6 feet 8 $\frac{3}{4}$ inches wide and the grate area is 63.9 square feet, and the fireboxes of the C. R. R. of N. J. and P. & R. engines are 9 feet 5 $\frac{1}{2}$ inches long by 96 inches wide, and the grate area is 76 square feet. Assuming the grate area of the C. B. & Q. engines (in round numbers 34 square feet) to be the proper one under the conditions of fuel and service, it would seem that it could be provided with greater operative efficiency, in an engine of the same type, and otherwise identical in construction, by the employment of a firebox, say, 6 feet long by 5 feet 8 inches wide, the width proposed being a very moderate one, and the length such that it could be much more easily fired than that with which the engines are now running. Any desired increase of grate area within the present limit of length could, of course, be obtained by increase of width or length, or both, to which, as before indicated, the Atlantic type is perfectly and specially adapted. If, on the other hand, the embodiment of the present grate area in a long and narrow firebox is believed to be the better practice, the substitution of a pair of driving wheels for the present trailing wheels, and the consequent utilization of 33,000 pounds of weight for adhesion, naturally suggests itself. The objection may be raised to the wide firebox that its employment would involve an undesirable increase of tube length, the tubes being now 16 feet long. To this it may be replied, first, that the increase of length required would not be sufficiently great to be objectionable, and, second, that it could be avoided by the use of a firebox of the form which has been proposed by Mr. M. N. Forney, in which the portion next to the tube sheet is narrow enough to stand between the driving wheels and the remainder is widened beyond them as in the ordinary wide firebox construction. This form would present the further advantage of permitting the forward portion of the firebox to be used as a combustion chamber, a plan which has been practiced with satisfactory results in anthracite coal burning engines and which should operate equally well with bituminous coal. It is, moreover, exempt from the objections which are thought to exist to a combustion chamber located within the waist of the boiler, and which have limited its application to a comparatively small number of engines.

The addition of the C. B. & Q. Atlantic type engines to the number of new and interesting constructions which the increasing demands of high speed passenger service have recently brought into use, naturally suggests criticism and discussion of their special features of design. The views which are here expressed are rather in the nature of indicating that they might be better than they are, than that they are not as good as they ought to be, and except as to the view of the writer regarding the form of firebox, there does not appear, so far as can be ascertained from the published data, any particular in which their design and proportions seem susceptible of improvement. With their liberal heating surface of 2,510 square feet, ample cylinder power, perfected piston valve steam distribution and large driving wheels, it is reasonable to believe that the results of their performance will fully equal, and even exceed, the requirements for which they were designed, and these results will be awaited with interest by the railroad community.

The draught appliances have not been illustrated, but are presumably of approved type, and the handsome and symmetrical appearance of the engines will be admitted by every intelligent observer. The comparatively short front and taper stack are not inconsiderable factors in this regard, and form a pleasing contrast with the huge extended smoke-boxes of the C. M. & St. P. engines of the same type, the unsightliness of which is made more impressive by the growing conviction that they are correspondingly useless.

NOTES ON THE EFFECT OF PORTS AND VALVE GEARS ON THE PERFORMANCE OF HIGH SPEED LOCOMOTIVES.

By R. A. Smart.

In recent numbers of the "American Engineer" and other of the railway journals, a number of editorials and communications have appeared on the general subject of high speed locomotives, in which emphasis has been laid upon the importance of having well balanced valves, heavy valve gears and large ports, in order that there may be no serious diminution of power when running at high speeds of rotation.

In order that a locomotive shall be able to maintain high speed with the modern passenger train, it should have such a perfected valve gear that the distribution of steam in the cylinder will be such as to develop the maximum power from every pound of steam used. The boiler has a very definite limit to its capacity and that limit is likely to be reached often with the majority of high speed locomotives. To secure the maximum effort, therefore, the valve gear should allow every pound of steam generated to count for as much as possible.

The difficulty usually encountered in securing a good distribution of steam at high speeds is two fold, (1) on account of insufficient port areas, which cause wire drawing, and (2) from badly balanced and heavy valves and light valve gears, causing serious distortion of the valve motion, both of which result in an uneconomical distribution of steam.

There is a tendency in some quarters to treat the subject of steam distribution as of small importance, the position being

shortly after. Both cylinders were similarly affected and at the same time. The mean effective pressure of the smaller card is 59.4 pounds, a loss of 15.4 per cent. Similar action was noted at other times with the same engine under other cut-offs and for steam pressures above 200 pounds.

The engine from which the cards were taken has a flat, well-balanced valve, but somewhat larger and heavier in proportion than is often used. It is, however, fitted with an exceptionally strong and well made valve gear. No undue springing of the parts of the gear was observable while the small cards were being taken. The lubrication was steady and of greater quantity than would ordinarily be considered good practice. On taking off the steam chest cover immediately after shutting down, the parts were found to be in good condition and well lubricated. The lubricant was evenly distributed and there was no evidence that the oil had collected in the pipe and dropped down when the throttle was closed.

The distorted valve motion was without doubt largely due to the use of a flat valve with high steam pressure. While a heavier valve gear and more lubricant would probably have reduced the distortion materially, no blame should be attached to those features, since they were designed to amply meet the conditions of ordinary service. This case is perhaps an exceptional one, but it shows what may happen under conditions which would ordinarily be considered favorable to good results, and serves to call attention to the importance of having light and properly balanced valves and strong, well made valve gears in order to secure a proper steam distribution.

Mention has been made of the importance of using large ports in order to avoid excessive wire drawing. The following



Fig. 1.—Left Head End.
Mean Effective Pressure, 70.16. Scale, 150.



Fig. 2.—Left Head End.
Mean Effective Pressure, 59.44. Scale, 150.

taken that so long as a locomotive pulls its train over the road, the question of steam economy is of comparatively small moment, and that if the cylinder power is insufficient, the remedy is to run with longer cut-off. That this position is not correct would seem to be the case when it is considered that given a locomotive running at high speed with a poor valve motion and consequently decreased power, and at the limit of its boiler capacity, the lengthening of the cut-off would not only increase the power of the locomotive as a whole, but might actually diminish it, whereas it might be possible to change the valve gear and ports so as to materially improve the steam distribution and thus increase its power by doing more work with the same amount of steam.

In order to show to what extent the locomotive valve motion may become distorted under ordinary conditions of running, two cards are shown in Figs. 1 and 2 which were taken from the same cylinder end under the same conditions, namely:

Speed 25 miles per hour
Throttle Fully open
Pressure in steam chest 210 pounds

The full card (Fig. 1) was taken at the beginning of the run and shows the normal distribution of steam. The mean effective pressure of this card is 70.2 pounds. The smaller card (Fig. 2) was taken after about thirty minutes continuous running. Cards taken a short time previous to the one shown indicated the beginning of the distorted motion and the action represented in Fig. 2 continued until the run was stopped

tabular statement shows what may be accomplished by this means in the way of increasing the mean effective pressure while retaining the same percentage of cut-off, release and compression.

	Cut-off.	R. P. M.	Initial Pres.	M. E. P.	P. C. Increase
Engine No. 1...	43.8	184	116	49.7	...
Engine No. 2...	42.3	194	111	59.3	19.3
Engine No. 1...	25.1	187	115	30.8	...
Engine No. 2...	25.8	193	119	47.4	53.8

The cards taken from the two engines under the conditions shown in the table were similar in every respect except as to the relative pressures. The increase in mean effective pressure given by engine No. 2 was wholly due to the use of an Allen valve and larger ports in proportion to the cylinder volume.

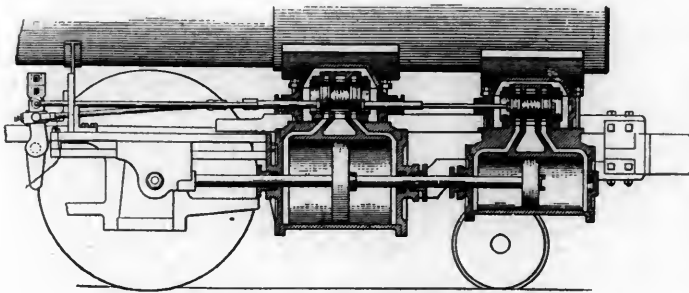
What has gone before serves to show the importance of careful attention to the design and construction of valve gears and ports, and to emphasize the relative importance of these details in their effect on capacity of the locomotive at high speeds. There is, however, one important consideration which should not be overlooked when an attempt is made to secure large ports. An increase in port area means generally an increase in the percentage of clearance which, it is usually conceded, should be kept as low as possible. An increase of but a few per cent. in the clearance above that which is ordinarily considered to represent good practice may result in a very marked decrease in the economy of the engine, thus losing all of the benefit which would be expected from the increased size of the ports.

PLAYER'S TANDEM COMPOUND LOCOMOTIVE.

The accompanying diagram illustrates the chief features of a new arrangement of compound cylinders recently patented by Mr. John Player, Superintendent of Motive Power of the Atchison, Topeka & Santa Fe Railway. Several engines have been built from drawings embodying this construction, and we are informed that the results on the road are satisfactory.

The cylinders are in two sets combined with half saddles and attached to a long smoke-box ring with sufficient space between the cylinders to admit of taking out the rear or low pressure piston without removing the high pressure cylinder, the piston rods being spliced for this purpose. Piston valves are used and an interesting feature of their construction is the absence of packing rings. The valves as first arranged had packing rings of the usual form and these were afterward replaced with narrower ones, until finally, on account of wear and friction, they were discarded altogether and the valves were made of cast iron in the form of plugs absolutely without packing.

The drawing does not accurately represent the construction of the locomotives, but it illustrates the principles. The real novelty in the plan is in the arrangement of the valve rods whereby the cut-off on the high pressure cylinder may be changed by a simple adjustment without interfering with that of the low pressure cylinder. The valve stem for the low pressure cylinder is hollow, and that of the high pressure cylinder passes through it. The valve rods have separate attachments to the upper rocker arm and by changing the



Player's Tandem Compound.

point of connection of that for the high pressure valve its travel is altered and the cut-off may be made suitable for the special conditions under which the engine is to work. It is clear that this arrangement of tandem cylinders avoids the extremely large steam clearances of some former designs of tandem compounds and this valve gear is not at all complicated. It is an ingenious and interesting plan, and if it demonstrates the possibility of using piston valves of the plug type and shows that the cut-off of the high pressure cylinder may be made adjustable as in marine practice it will attract a great deal of attention. It seems likely to accomplish these results.

Fearless discussion of suggested departures from current practice, such as is held before the American Railway Master Mechanics' Association, is thought by our English contemporary, "The Mechanical World," to explain American leadership in locomotive matters.

The claim made by Mr. Tripler that he makes ten gallons of liquid air by the use of three gallons has been answered by President Henry Morton by showing that Tripler produces a gallon of liquid air by the use of 10 horse-power hours, whereas, even in an ideally perfect engine, only three-quarters of one horse-power hour may be obtained from this quantity of liquid air when used as a source of power.

THE CONSTRUCTION OF A MODERN LOCOMOTIVE.

By T. R. Browne, Master Mechanic Juniata Shops, P. R. R.

The Arrangement and Division of Labor.

VIII.

Probably no other element in the construction of the modern locomotive or in general manufacturing has a more direct bearing upon the fluctuations of cost as connected with the management of a plant than the character, division and management of the labor employed. Even the best and most modern machinery and general equipment will utterly fail of its purpose with indifferent and unskillful handling and we consider the labor, in which we include the men actually employed on production, therefore, a very special part of the equipment of the plant, and their selection and management, considered from the standpoint of equipment, must receive the same general order of consideration as that used in selecting the appliances which they are to operate.

It is obviously unprofitable to employ a high grade of mechanical labor in the operation of machines when those machines may be equally well operated by a lower grade of labor and at much less cost. The great improvements that are being made in facilities for general manufacturing render the employment of a high grade of labor for their operation unnecessary, although many times, we think, this point is overlooked, and a skilled mechanic is employed to operate a machine when a much lower grade of labor would answer equally well. It is upon the amount of labor charged against a given amount of output that the profits or earnings to cover expenses of operation and other expenses of the plant are charged, and the character of this labor must be such as to produce the largest amount of output at the minimum cost.

Taken generally, the plant may be divided into two parts: The producing portion and the non-producing portion. As a result of the operation of the first, the profits and income must be such as to pay the expenses of the second. In the producing portion of the plant each machine must, by reason of its earnings, contribute a proportion of the expense of its operation, repairs, etc., as well as a proportionate amount of the cost of maintaining the balance of the plant and its operating expenses. It will be obvious that, in proportion as the original cost of a machine is greater, the proportion of the expenses of the plant which it shall bear will be increased and the necessity for its economical and profitable operation become more emphatic. The value of the output from this machine, independent of expenses, is represented by the value of the raw material, plus the labor of completing it; and this labor alone, in most cases, must earn the proportion of the expenses of operating and maintaining the plant which are charged against this machine.

The general arrangement and ranking division of all labor throughout the plant should be such as to encourage a regular system of promotion from the lowest grade to the highest, and in accordance with the ability of the man. It has been found that the larger part of the labor employed can be considered as specialists, or a class of men who do not have a trade, but have risen from the ranks of lowest labor by reason of peculiar fitness for some special line in which they have become more or less perfect; and the policy of selecting from the most ordinary laborers employed men who are trained as specialists has been found most successful in providing not only efficient and careful employees on the line of work which they are specially trained for, but a force which is contented and reliable. In their rank as specialists they start at a rate of pay which is slightly more than that paid the ordinary laborer, and from time to time are increased in their rating as they become more proficient; length of service also has something to do with the question of rate. They do not, however, ever reach the regular rate paid the skilled mechanic. In referring to skilled labor, that class of labor or mechanics are meant who are capable of performing any kind of work in their line of trade.

There is a class just below this who are not quite as high up in their trade and who can very properly be ranked as the highest order of specialists, and for the sake of illustration, we have assumed this latter class as included in the so-called specialist. Another source of supply for renewal of this class of labor is from the ranks of young men who are too old to learn a trade, and yet below age and not entitled to employment as full-grown men. This class of young men are placed on machines or various work throughout the plant, and a careful record kept of their performance and skill, and at least every six months tried on a new class of work, not only for their encouragement, but for the purpose of determining their best efficiency. These young men eventually become specialists in similar manner to the class of men above referred to, and this system frequently develops what proves to be a very valuable man.

Where piece-work is generally adopted, both of these classes of labor work on a piece-work basis, in which case their earnings are considerably more than their regular rate by the day. It is pretty well recognized that in neither a railroad or locomotive shop, where the construction of locomotives constitutes the main industry, can any one of the trades be thoroughly learned, at least in that sense that a man who has learned his trade under those circumstances is thoroughly fitted to compete with the highest grade of mechanic, who can take up practically any kind of work, or who has learned his trade in a shop where the character of the work is much finer and closer than that required in the construction of the locomotive. It is, however, true that the experience which the apprentice will gain in a locomotive shop is a most valuable introduction to the trade which he has adopted and to further experience in the same trade at other shops.

In connection with the construction of the locomotive there are practically eight trades represented, this division of trades representing approximately an equal number of departments in which the work in this line is carried on. The advantage of having a trained force in each one of these departments will be appreciated, and the arrangement of apprentices, from which the supply of skilled labor to a very large extent is drawn, is such as to give them a training in such of these trades as they may select, and while the complete trade, as above intimated, cannot be taught them, at least so much of it as may be useful at the plant and make them valuable as employees may be acquired; and it is from the best of these apprentices in each one of these trades that the skilled labor is generally drawn to fill that particular rank. The men employed throughout the plant should be assured that from the lowest position they can be promoted and rise to the highest directly in proportion to their skill and faithfulness, and, independent of the fact that they do not possess a regular trade, can occupy a position, by reason of their skill in one direction, and which will pay them almost, if not quite, the rate of the mechanic. This has the effect of continued encouragement to advance themselves by every effort in their power.

Independent of the operation of the various facilities throughout the plant, or that type of work on which the specialist can be employed to best advantage, there is the repair work, special work, and even work in connection with actual production, which requires the services of the most skilled mechanics, the object being to use this class of labor for maintaining the equipment which specialists are used to operate and such general equipment throughout the plant as may be incidental to its operation. In a general sense, the division of labor throughout the plant consists of the ordinary or lower grade of labor used in connection with the handling of material and general work requiring such labor; the specialists or shop hands, who are employed directly in production; the apprentices, from whom are drawn the supplies of skilled labor or mechanics, and the skilled mechanics, who are used on that character of work requiring their peculiar skill, and which cannot be performed with the same economy by specialists.

Grouping the ordinary laborer, specialist and the apprentices together, they constitute fully 82 per cent. of the labor em-

ployed, the remaining 18 per cent. being represented by the skilled mechanics. It is obvious that the percentage of skilled labor required for this class of work will vary somewhat with the nature of the work, and is therefore different in different departments. Considering only the four principal shops, owing to the fact that the largest amount of labor is employed in these departments, the proportion of specialists or unskilled labor as compared to skilled labor in each one of these departments, these proportions being intended to represent numbers of men and not amounts of money, would be about as follows: In the blacksmith shop it will amount to 70 per cent., as compared with 30 per cent. of skilled labor; in the boiler shop, 80 per cent., as compared with 20 per cent.; in the machine shop, 88 per cent. and 12 per cent.; and in the erecting shop, 91 per cent. and 9 per cent.

The writer is convinced that the question of distribution of labor and its character, in proportion to the character of work to be accomplished and the demands of each particular case, will amply repay the closest study, and that the amount of economy to be derived by a proper arrangement of labor will entirely offset the additional amount of salary which the character of skill and ability on the part of the foremen to look after a matter of this kind would command.

The division of labor by operations to be performed must, to a very large extent, be dependent on the methods to be followed in construction, and will also be controlled by the character of facilities and the arrangement of shop. The ideal condition would, of course, be one in which a division of the whole locomotive could be so made as to bring along every one of its parts at or about the same time and without interfering with any part of the general work.

The arrangement of the division of the force by operation will also to a very large extent depend upon the personal ability of the foreman in charge of the department; and the best man in this respect, at possibly the highest rate of pay, is not too good, in our estimation, to accomplish the results which can be brought about by a careful consideration of this whole subject.

PERSONALS.

Mr. James Thompson has been appointed Superintendent of Motive Power of the Pennsylvania Division of the New York Central to succeed Mr. W. A. Foster.

Mr. C. F. Winn has been appointed Master Mechanic of the Chesapeake Beach Railway, with headquarters at Washington, D. C.

Mr. G. R. Brown has retired from the position of General Superintendent of the Fall Brook Railway, owing to the absorption of the road by the New York Central.

Mr. A. C. Deverall, Superintendent of the St. Cloud shops of the Great Northern, has been promoted to the position of Superintendent of the car and machine shops at St. Paul, to succeed Mr. S. F. Forbes, promoted.

Mr. G. L. Warren, for the past fifteen years Chief Draftsman for the Chicago, St. Paul, Minneapolis & Omaha, has been appointed Mechanical Engineer.

The Baltimore & Ohio has appointed Mr. W. C. Hayes locomotive superintendent. He will have charge of all enginemen and engines while on the road and will instruct the men in the handling of the engines, but will refer questions of discipline to the Master Mechanics. He will have charge of the traveling engineers. The traveling engineers will examine and employ firemen under the customary physical and educational requirements. This plan places the operation of the locomotives in the hands of one man and much may be expected from this in the way of uniformity of instruction and service.

Mr. Schuyler Hazard has resigned as Principal Assistant Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railway, to engage in partnership with Mr. Thomas Lee of Cincinnati in the sale of Lumen bronze and anti-friction metals, as noted elsewhere. These bearing metals are the invention of Prof. R. C. Carpenter of Cornell University. Mr. Hazard is a member of the American Society of Civil Engineers and is a young man to have held the important position in the "Big Four" that he now leaves. He graduated in civil engineering from the Massachusetts Institute of Technology in 1890, and almost immediately entered the service of the P. C. C. & St. L. Railway at Pittsburgh. He soon after went to the "Big Four" as first assistant engineer of the Peoria division. His next advance was to take the position of assistant engineer of the Cincinnati and Cleveland divisions. Then he was made engineer of maintenance of way of the Cleveland division, after which he was put in charge of construction. His appointment to the position he has just resigned followed quickly after the others mentioned. Mr. Hazard has a wide acquaintance and the ability he has shown in railroad work promises success in his new undertaking.

Charles M. Higginson, assistant to the President of the Atchison, Topeka & Santa Fe Railway, died at his home in Riverside, Ill., May 6, after a brief illness. He was a valuable officer and contributed in a very important way to the success of the present administration of the Atchison properties. Another assistant to the President may be appointed, but it will be extremely difficult to fill his position because he was fitted by rare perception, searching insight, patient perseverance, wide experience and unusual foresight in the administration of the details of railroad operation. His was a modest, retiring disposition and he was sometimes misunderstood, but those who knew his work and his chief idea in the consideration of a business question—"What is there in it for the Atchison road?"—were bound to admire him and his devotion. His work was so well outlined and so thoroughly organized all over the system that the properties will continue to reap the benefits, and this is a good test of its character and quality. Mr. Higginson began railroad work in 1865 in the engineer's department of the Burlington & Missouri River R. R. He was appointed Purchasing Agent of the Toledo, Peoria & Western in 1875, the following year he became Purchasing Agent of the Chicago, Burlington & Quincy, and in 1879 was made Assistant Auditor with special charge of statistics. In 1890 he became Assistant to the Vice-President, and Mr. E. P. Ripley appointed him as his assistant upon taking the presidency of the Atchison. Mr. Higginson was born in Chicago in 1846 and received his education at the Lawrence Scientific School of Harvard University. He was interested in scientific studies and was a recognized geologist. He was a member and for several years President of the Chicago Academy of Sciences, he was one of the Board of Managers of the Young Men's Christian Association in Chicago and a Fellow of the Royal Society of Great Britain. He will be missed by many and not least by the young men whom he had selected for positions in the various departments of the road.

Captain Alfred E. Hunt, one of the founders of the Pittsburgh Testing Laboratory and President of the Pittsburgh Reduction Company, died suddenly at the Hotel Lafayette, Philadelphia, April 26, from illness contracted during his service in Porto Rico in the recent war. Captain Hunt was very prominent in metallurgical matters. He was born at East Douglass, Mass., in 1855, and was educated in the schools of Boston, graduating in mining and metallurgical engineering from the Massachusetts Institute of Technology in 1876. His first professional work was with the United States Geographical Survey, after which he was connected with the Bay State Iron Works at South Boston, where the second open hearth steel furnace in this country was erected. From there he was sent to Michigan

to explore for iron ore, and his report led to the opening of the Michigamme mines and the development of the Wisconsin and Michigan iron regions. Next he went to Nashua, N. H., as manager and chemist of the open hearth steel works there and later became chemist and superintendent for Park Brothers, Ltd. In 1882, with Mr. George H. Clapp, he formed the firm of Hunt & Clapp for the purpose of testing and reporting upon materials and the inspection of iron and steel structures. The business grew rapidly and after ten years a stock company was formed, which is now so widely known as the Pittsburgh Testing Laboratory, Limited, and is recognized as the leading establishment of its kind in the country. In 1888 Captain Hunt began the production of aluminum and organized the Pittsburgh Reduction Company to manufacture it on a large scale. The wide introduction of this metal, which was due to the reduction of the cost of production, is attributed chiefly to him. His standing as an engineering, chemical and metallurgical expert was high and the courts frequently required his testimony in difficult cases. He wrote a number of valuable scientific papers, which have been published in the proceedings of the national technical societies. He was a member of the American Society of Mechanical Engineers, the American Society of Civil Engineers, a fellow of the American Society for the Advancement of Science, a member of the Iron and Steel Institute of Great Britain and of other prominent technical organizations. He was prominent in military matters and was Captain of Battery B of the National Guard of Pennsylvania, and during the recent war he led his command on the expedition to Porto Rico. Captain Hunt was successful in his business undertakings and he will be missed by business and professional associates and by a very large number of friends.

EQUIPMENT AND MANUFACTURING NOTES.

The Ajax Metal Co., of Philadelphia, have not entered the combination of firms of manufacturers of bearing metals, and do not propose to do so. This concern will continue to produce superior bearing metals, as in the past, at the lowest possible prices and entirely independent of the trust.

J. A. Fay & Egan Co., the largest manufacturers of wood-working machinery, whose plant is located at Cincinnati, Ohio, have demonstrated that prosperity has returned in their line of business by building a large addition to their plant, which is now being equipped with the most modern tools. May 1st the wages of employees were raised 10 per cent. without solicitation from the men, which is the best possible indication of a satisfactory condition of business and a return of "good times."

Mr. Daniel M. Brady, for the last eleven years President of the Brady Metal Company, has severed his connection with that firm and has organized the Brady Brass Company, with general office and works at 202 Tenth St., Jersey City. The new company manufactures high grade castings and metals for bearings and other details of steam and street railroad work. Mr. A. Onslow, formerly for seventeen years Superintendent of the D. A. Hopkins Self Fitting Lead Lined Journal Bearing Company, and for eleven years Superintendent of the Brady Metal Company, has associated himself with the Brady Brass Company as General Superintendent.

The Graham Equipment Company, of Boston, have received an order for 135 auto-trucks from the National Transportation Company, of that city, for use in the construction of equipment for various bus lines which are being established in the suburbs. They will have steel frames and will be equipped with Graham's spring suspension and equalized brakes and rubber tires will not be used. Another order has been received for 12 combination smoker and baggage cars, five 10 ton steel coal cars and five flat cars of the same capacity for an electric road in Massachusetts. They will have Graham's steel underframes, made of merchant shapes, secured by bolts, and his spring suspension and equalized brakes. This company is building two sample trucks for the Goodwin Car Co. for exhibition at the June conventions.

The Magnolia Metal Company have opened an office in Montreal, Room 524 Board of Trade Building, for the convenience of their Canadian business.

C. L. Berger & Sons, successors to Buff & Berger, instrument makers of Boston, have just purchased the famous Wardeman automatic circle-dividing engine, which graduates a circle to 5 seconds of arc within a limit of error of one second. There are only two in this country to-day which can do such fine work. On account of their increasing business they have been obliged to enlarge their works, increase their force, and add materially to their machinery. April 29 they celebrated by appropriate ceremonies the completion of their three thousandth instrument. Their catalogue, just issued, is a hand-book and treatise on the construction and care of instruments of precision, full of valuable hints and information.

In the earlier days of the use of Russia sheet iron in this country its cost per pound ranged as high as 25 cents. In fact, up to the time that Wood's patent planished sheet iron was invented and put upon the American market, and for a short time afterward, the market price varied from 15 to 25 cents. Not long after its advent the American product was demonstrated to be superior to Russia iron in quality, uniformity of color, gauge, and finish. Moreover, it was placed upon the market in dimensions to suit requirements. And not only did it possess superiority of quality, but its price was fixed at a figure much lower than that of Russia iron. Wood's patent planished sheet iron has driven Russia iron out of the market, and it costs the consumer rather less than one-half the price formerly charged for Russia iron.

Mr. Thomas Lee, of Cincinnati, and Mr. Schuyler Hazard, formerly Principal Assistant Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., have formed a partnership, with offices at 209 Race Street, Cincinnati, for the sale of the Lumen metals in the States of the middle west, the south and the southwest. "Lumen" was discovered and perfected by Prof. R. C. Carpenter, of Cornell University, and upon subjecting it to thorough laboratory tests it was put on the market and has been adopted and is used by a number of prominent engineering firms. It melts at 680 deg., has a specific gravity of 6.9; tensile strength, 31,000 lbs.; compressive strength, 70,000 lbs.; its coefficient of friction is 0.00625, and it may be poured like babbit.

The Chicago Pneumatic Tool Co. has purchased the patents formerly owned by the Consolidated Pneumatic Tool Co., now defunct. These patents include all the Keller and Wolstencroft types of tool construction and in addition several new applications which have not yet been taken out. These patents originally cost the Consolidated Pneumatic Tool Co. about \$40,000. Mr. Sidney H. Wheelhouse, formerly with the M. M. Buck Manufacturing Co., St. Louis, has become connected with the Chicago Pneumatic Tool Co. as southwestern agent, with office and salesroom at 409 North Fourth Street, St. Louis. The satisfactory condition of the business of this firm is shown by the large number of orders received. We are informed that May 8, at the Chicago office, the mail orders called for 81 pneumatic hammers and riveters, 57 drills of different sizes, and 17 miscellaneous tools, a total of 155 tools ordered in a single day. Among recent orders is one for eight pneumatic riveters, for Shanghai, China. The Chicago Pneumatic Tool Company and Joseph Boyer have begun suit in the United States Court at Philadelphia against the National Pneumatic Tool Company for infringement of patents covering the Boyer pneumatic hammer.

The Pressed-Steel Car Company has arranged to have a comprehensive exhibit of its various styles of cars at the Old Point Comfort Conventions. Not only will their types be shown in new cars, but a complete series of cars manufactured early in the history of the company and since then in use by prominent roads, will be exhibited. The cars will be sent to Old Point Comfort in exactly the condition in which they are received from the roads, in order that there may be, for the benefit of railroad men, an ocular demonstration as to how the cars wear in service. Of the old cars to be on view the Pennsylvania Company will contribute one; the Baltimore & Ohio, one; the

Pittsburgh, Bessemer & Lake Erie Railroad, one self-clearing hopper, and the Lake Superior & Ishpeming Railroad, an ore car. The exhibit will be not only interesting, but instructive.

The firm of Manning, Maxwell & Moore, and its kindred interests, the Ashcroft Manufacturing Co., The Shaw Electric Crane Co., The Consolidated Safety Valve Co., The Pedrick & Ayer Co., and the Hayden & Derby Manufacturing Co., whose New York offices and salesrooms have been located a great many years at Nos. 111 and 113 Liberty street, have removed to the new Singer Building, 85, 87 and 89 Liberty street, corner of Broadway. The change has been found necessary owing to the steady increase of business done by the firm. The new quarters are large and convenient, and arranged to meet the situation fully. The ground floor will be devoted to show rooms and has facilities for carrying a complete stock of everything pertaining to the business. The first floor will be occupied entirely by the business offices, which are complete in every detail, being fitted throughout with the most modern appliances to enable the large volume of business transacted to be handled conveniently, economically and expeditiously.

"Axle Light" equipment, furnished by the National Electric Car Lighting Co., 71 Broadway, New York, has been ordered by President Truesdale of the Delaware, Lackawanna & Western, for 15 new passenger coaches now building at Dayton, Ohio. They are to run in suburban service. The Atchison, Topeka & Santa Fe have also contracted for 34 cars in addition to the 88 already equipped with electric lighting, the new cars to run between Galveston and Houston, Texas. Among other recent installations are the Illinois Central officers' Car No. 2, now on a trip to Mexico, and the private car "Emmalita," of Mr. George Crocker, Vice-President of the Southern Pacific Company. This car recently carried Mr. Crocker and a party of friends from New York to San Francisco. It was in the charge of the colored porter, who gave all necessary attention to the lighting equipment and, we are informed, abundance of light was furnished with power to spare for running electric fans.

The Third New York Electrical Exhibition opened at the Madison Square Garden May 8 with the usual simple ceremonies, including an address by Senator Chauncey M. Depew. The exhibition will be open until June 3, and during its progress the New York Electrical Society will hold several technical meetings. The exhibition is held under the auspices of the National Electric Light Association and the annual convention will be held during the exhibition. The chief feature of the exhibition is to show progress in automobile carriages, of which a large number of admirable examples are included. A collection of electric lamps arranged chronologically is exceedingly interesting, and among the novelties are wireless telegraphy and the use of a searchlight to transmit speech. The exhibit of direct connected motors for machine tool driving and that of the signal corps of the United States Army are specially interesting. There are fewer exhibits than last year and the selection has been made with care.

The Pneumatic Supply & Equipment Co. has been organized under the laws of the State of New York and has opened an office at 120 Liberty street, New York. It is the purpose of this company, as its name implies, to deal generally in compressed air equipment and it will make a specialty of the installation of complete plants, eliminating the division of responsibility which has heretofore existed. The company is bringing out several specialties in the compressed air line, such as pneumatic oil rivet forges, quick acting hose couplings, and has in addition arranged agencies for several standard types of compressors. Mr. J. W. Duntley, the President of the Chicago Pneumatic Tool Co., is the President of the new company. Mr. E. B. Gallaher, formerly with Messrs. Patterson, Gottfried & Hunter, is Vice-President and Engineer, and Mr. W. P. Pressinger, formerly Manager of the Clayton Air Compressor Works, is Secretary and Treasurer. The rapidly widening scope of compressed air application opens a large field of usefulness for the new company, and the character of its incorporators is an assurance of its ability to meet the requirements.

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THIRTY-THIRD ANNUAL CONVENTION.

MASTER CAR BUILDERS' ASSOCIATION.

The convention was called to order at 10 A. M., June 14, at Hotel Chamberlain, Old Point Comfort, Va., by the President, Mr. C. A. Schroyer. The session was opened with prayer by the Rev. J. J. Gavitt, of Richmond, Va., after which Mr. Chas. T. O'Farrell, ex-governor of the State of Virginia, delivered an eloquent address which was full of patriotic enthusiasm and felicitation concerning the result of the recent war, the entire time covered by which was but 103 days. This, and the wonderful progress of this country was largely due to the influence of mechanical men and the important position of the country politically and commercially was chiefly brought about by the men whom the speaker addressed.

The courtesies of the army post at Fortress Monroe were then extended to the association by Col. Gunther, Commandant, which was followed by the address of President Schroyer, who began with the statement that the value of the cars represented by the association now amounted to over \$500,000,000, which fact conveyed an idea of the responsibilities involved. The improvement in the harmony in the interchange of cars was indicated by the fact that but 35 cases had been brought before the arbitration committee for ruling. The speaker briefly reviewed the reports of the various committees and expressed his satisfaction with the good condition of the association generally.

The report of the Secretary contained the usual statistics and showed the membership to be as follows: Acting members 260, representative members 191, and associate members 7; a total of 458. The cash balance of funds handed over to the treasurer was \$458. The treasurer reported funds on hand amounting to \$8,893.12, all bills having been paid. It was voted to allow the membership dues to remain as last year, \$4.00 per vote. After the appointment of a committee on nominations and an auditing committee Mr. J. O. Goben, Master Car Painter of the "Big Four" Railroad, addressed the meeting on behalf of the Master Car Painters' Association, urging closer co-operation between the two associations and enlisting assistance and encouragement for the M. C. B. Association. The matter was ordered referred to the committee on subjects for the convention of 1900.

Mr. McConnell presented a report of the conference between the executive committees of the M. C. B. and M. M. associations consisting of a recommendation which was in effect as follows:

That the time of holding both conventions should be changed to the second Tuesday in June.

That a joint opening session of both associations should be held at 10 o'clock A. M. of that day to hear the addresses, including the addresses of the presidents of both associations and the annual reports of the treasurer and secretary of the two associations. After this is over—

The Master Mechanics' Association to have the time up to 1 P. M. Tuesday.

The Master Car Builders' Association to have Tuesday afternoon.

The Master Car Builders' Association to have all of Wednesday.

The Master Mechanics' Association to have Thursday A. M.

The Master Car Builders' Association to have Thursday P. M.

The Master Car Builders' Association to have Friday A. M.

The Master Mechanics' Association to have Friday P. M.

If any further time is required by either association it can be available on Saturday, but it is not thought that this will be necessary.

The order of business of the joint meeting on Tuesday morning is to be arranged jointly by the presidents of the two associations, and to be published in the programme for both conventions.

After a brief discussion the subject was deferred for decision until the closing session.

Topical Discussions.

No. 1. "Is a lock set and knuckle opening device in M. C. B. automatic couplers essential to completely fulfill all the requirements of an automatic coupler?"

Opened by Mr. W. S. Morris. The law did not include the knuckle opener and lock set (a lock to the lock, to prevent accidental unlocking on the road) but stopped at the automatic coupling of the couplers. The speaker, however, considered these attachments important and necessary. Mr. Bush supported Mr. Morris in the opinion that couplers should be so equipped as to avoid the necessity for men to pass between the cars in coupling or uncoupling them.

No. 2. "In the interchange of passenger equipment cars, what is and should be the practice in regard to charging for Pintsch gas in cars lighted by this system?"

Mr. G. W. Rhodes presented the subject and suggested the use of the M. C. B. defect card for the amount of gas measured in atmospheres, for the pressure registered by the gage on the car and recommended that this should be included in the rules for the interchange of passenger cars.

No. 4. (Third subject deferred.) "Has the splicing of air brake hose been found to be good and economical practice, and should cars so equipped be passed in interchange?"

Mr. J. N. Barr answered this in the affirmative. Mr. J. W. Luttrell supported this opinion. Spliced hose on the Illinois Central, at the rate of about 1,200 pieces per year, was thus repaired at about 14 cents each, and when tested at 200 lbs. pressure the practice was perfectly safe. Mr. Garstang repaired enough hose in this way to save between \$300 and \$400 per month and confirmed the opinion as to its safety. Mr. W. S. Morris dissented. He had found difficulty due to poor judgment in selecting hose to be spliced and did not approve of the practice, but the general opinion was favorable.

No. 5. "Fastening of ladders, hand holds, brake wheels and brake shaft brackets on freight cars and the inspection of the same, from the standpoint of greater safety to trainmen."

Mr. E. D. Bronner recommended improvements in these details which were important to the safety of trainmen and should be provided for in the rules. Lag screws were dangerous from the liability of rusting and pulling out. Bolts were preferred. Mr. Ball (Lake Shore) recommended securing all ladders with one-half inch bolts. Mr. John Hodge (A. T. & S. F.) had abandoned lag screws in favor of bolts, considering the latter much safer than the former.

COMMITTEE REPORTS.

Supervision of Standards and Recommended Practice of the Association.

This report was read by abstract by the secretary.

On motion recommendation No. 1 was adopted; recommen-

dition No. 2 was submitted to letter ballot; recommendations Nos. 3 and 5 were adopted by the association; recommendation No. 4 was submitted to letter ballot; recommendation No. 6 was adopted by the association. The five subjects mentioned at the close of the report were referred to the committee on subjects.

Triple Valves.

This report was presented verbally by the chairman, Mr. Rhodes, who stated that the test rack had been transferred from Altoona, Pa., to the laboratory of Purdue University and that no triple valves had been submitted for testing during the year. In response to questions by Mr. Barr as to why tests had not been made on the triple valve of the New York Air Brake Co., Mr. Rhodes offered the following explanation and suggestions:

At the last annual convention the following motion was offered by Mr. Mitchell: "I therefore make a motion that the standing committee on triple valve tests this year obtain triple valves from the manufacturers and make tests of them and report the results of its tests to this convention next year, giving specific names and referring to catalogue numbers." The motion was adopted, and the committee put itself in communication with the manufacturers of the New York air brake and endeavored to obtain triple valves from them for test. The president of the New York Air Brake Company wrote back to the chairman of the triple valve committee, saying that they would not furnish any triples for test. The reasons given were two, the principal reason being that owing to an opinion given by the late Mr. Massey, in 1898, following a conversation with the chairman of the committee, they objected to one of the requirements in test No. 2. The requirement reads as follows: "The final maximum pressure in this test must not be less than 15 per cent. nor more than 20 per cent. above the pressure given by the same brake in full service application." Mr. Massey, in a communication to me, told me that the New York air brake would not meet that requirement, and he wished the committee to consider a modification of these rules. He acknowledged that it was a good feature in a triple valve, but did not consider it was a vital or essential feature, and wished the committee to change it.

On that score the New York Air Brake Company objected to submitting their triples for test. They make the further argument that they have a large number of triples in use, but that the present composition of the committee on triple valve tests is such that no member of the committee has had experience in the use of their triples, and that they did not think their triples would get the attention or the care that they would if some of the members knew more about the advantages of this triple valve. I thought that both these points were legitimate objections, and are points that this association should give some attention to. The recommendations for the tests were made in 1893, when we were pretty fresh from a large number of practical road tests, both at Burlington and subsequently on the New York Central Road, and it would look to me to be quite reasonable that if there is any number of interests involved which would like to have these rules gone over and reinvestigated, this association should consent to that and perhaps recommend it.

It is true that at the time this matter was brought up that the committee then had no experience with the present New York triple, and I see no objection at all (I think it is rather a desirable thing) that there should be one or two members on the committee who have had experience with and know the service given by the New York triple. There are an abundance of them in service now.

Mr. Barr then said: "In accordance with the suggestion of Mr. Rhodes, I would move that there be added to this present committee two members who are familiar with the practical working of the New York air brake in actual service and in considerable quantities."

This motion was voted down.

SECOND SESSION.

Triple Valves.

In concluding the action on the report of the committee on tests of triple valves Mr. Barr moved: "That the committee on tests of triple valves be instructed to carefully consider the present recommended practice, with a view of determining whether any modification of the same is allowable; that they obtain sets of triple valves and make such tests of them, both on the rack and on trains, as may be necessary to give this association full information as to the construction, and that they be authorized by and with the consent of the executive committee to make the necessary expenditures from the funds

of the association, the same not to exceed five thousand dollars."

The motion was passed after considerable discussion with regard to authorizing the committee to invite the air brake companies interested in the tests to assist. It was the opinion of the convention that the committee needed no instruction in this regard but that every available source of information would be utilized in order to render the reports perfectly fair to all concerned.

Interchange Rules.

The report of the arbitration committee was approved by the association.

It was then remarked that on account of recent changes in the rules the number of cases brought before the arbitration committee was greatly reduced, which was considered as an indication that the rules were now working well and that few changes were necessary. Three of the railway clubs had indicated their desire that the rules should not be changed at all. The rules were considered separately and owing to some lengthy discussions over details, the time given to the rules was three hours. The suggestions of the arbitration committee were adopted in nearly every case and there were no important changes made that were not brought forward by that committee. The question of whether the use of spliced hose should be provided for in the rules brought out considerable discussion, in which it was shown that it was not in accordance with the principles of the association for one road to dictate to another as to the safety of certain practices under dissimilar conditions. Mr. Barr thought that the roads with comparatively level profiles might use spliced hose without bad results, while perhaps that could not be said of mountainous roads, and he thought that it was not necessary to take any official action. This opinion prevailed and roads are free to refuse spliced hose if they do not consider it safe. The question was laid on the table. The prices allowed for M. C. B. couplers and parts thereof were referred back to the committee for further investigation. The entire action on the rules was practically the acceptance of the recommendations of the committee.

Passenger Rules.

A special committee on the revision of these rules reported a recommendation to permit the use of the M. C. B. defect card as an authority to make a bill for the Pintsch gas in the reservoirs of cars offered in interchange. This was referred to a committee for report next year and a recommendation providing for a committee to revise these rules for report next year was adopted. The present passenger rules were then adopted for the year as they stand.

Additional Compensation for Car Repairs West of the 105th Meridian.

This subject caused a spirited discussion last year, and the arguments in the case were summed up on page 373 of our November, 1898, issue. The committee this year did not favor an allowance for the benefit of the western roads and Mr. McConnell did not sign the report. He explained his reasons in the convention, repeating substantially the arguments of last year. He was supported by Mr. Hickey, the remarks of both gentlemen being a protest against the recommendation of the committee, but when put to vote the report was accepted, ordered printed and the committee discharged. This disposed of the question and no allowance will be made unless the subject comes up again.

Wheel and Track Gages.

Mr. Barr presented a verbal report, stating that he had conferred with the American Railway Association and that the matter was considered as a "dead letter" and would not require any important change in practice. The association referred to intended to make tests with a 50-car train on the Muskingham Valley Railroad, which were expected to develop interesting information.

Brake Shoe Tests.

The report of the committee was read and the committee continued, after which the session adjourned.

THIRD SESSION.

Square Bolt Heads and Nuts.

The report of this committee was presented in abstract by Mr. Haskell, who explained the co-operation between the committee and several manufacturers of bolts. There was no standard among the makers and the claim that heads made to dimensions other than the present Association standard had an advantage in strength over those thus made was sustained by tests conducted by the committee. The continuance of the work was suggested by the committee and further co-operation with the American Society of Mechanical Engineers, the Master Mechanics' Association and the manufacturers, looking to the selection of a joint standard. The report concluded with recommendations in regard to changes in the standard which would make the heads in accordance with the Sellers standard. These heads, while smaller, were stronger and were cheaper to make than the larger M. C. B. heads, as well as stronger. Mr. Delano moved that the American Society of Civil Engineers and the American Society of Mechanical Engineers be asked to co-operate in the adoption of this standard. This motion was passed, whereupon Mr. Barr moved that the Sellers standard should be adopted as recommended practice. This would make the width of the head of square bolts $1\frac{1}{2}$ times the diameter of the bolt, while the thickness of the head is one-half the width of one side of the head. This motion prevailed and the same subject is before the Master Mechanics' Association.

Interchange Rules.

The prices for couplers and parts of couplers was taken up again, the committee recommendation being that the prices of malleable parts other than the shank should be $3\frac{1}{2}$ cents per pound and similar parts of cast steel should be $4\frac{1}{2}$ cents, while the other prices on couplers should remain as recommended by the committee on prices, \$4.50 for coupler shanks and \$7.50 for complete couplers. This was voted upon and passed, after which the interchange rules, as recommended, were adopted as a whole.

Joint Meeting of M. C. B. and M. M. Associations.

This subject was brought up for decision on the recommendation offered in the first session. After discussion the plan was approved by the association, as already printed, except that it was changed so that the M. C. B. Association would meet on the first three days of the convention week, with the hope that the M. M. Association would use the other three days. Mr. Waitt moved to authorize the executive committee to arrange the next convention on this basis.

Mr. McConnell presented complimentary resolutions concerning Mr. Cloud's excellent work as secretary, expressing the regret of the association that he could not be a candidate for re-election because of business reasons. They were carried unanimously, and Mr. Cloud made a brief reply expressing his appreciation.

COMMITTEE REPORTS.

M. C. B. Couplers.

This was the most important of the reports and an admirable piece of work. Its objects were to define the contours more fully when new, to define them more fully when worn and to propose specifications for couplers. Mr. Barr moved a vote of appreciation of the excellent work of the committee. The recommendations were taken up separately.

(A) That concerning the increase of the length of the guard arm was amended to complete the curve at the end of the guard arm beyond the point defined by the committee and was passed. The change will be submitted to letter ballot.

(B) The vertical dimension of the knuckle was recommended for increase to 9 inches. Mr. Rhodes directed attention to the desirability of reducing the width of the opening in the knuckle for the use of links of link and pin couplers, for the purpose of increasing the strength of the knuckle. Mr. Atterbury stated for the committee that the present width of opening was considered necessary. This recommendation was submitted to letter ballot.

(C) The vertical dimension of the end of the guard arm to be placed at $7\frac{1}{2}$ inches as a minimum was also submitted to letter ballot.

(D) The same action prevailed as to the use of the twist gage for new couplers except that this was presented for recommended practice instead of as a standard, as in the previous cases.

(E) It was recommended that the horizontal plane containing the axis of the shank of the coupler be made to bisect the vertical dimension of the knuckle and the end of the guard arm. This was referred for adoption as a standard.

(F) The association endorsed the recommendation to the effect that "the gage for new knuckles be used on all knuckles purchased separately for renewals."

(G) It was recommended that the vertical height of the stop shoulder or horn of couplers be not less than three and one-half inches, and that the horn be arranged to touch the striking plate before the back of the head of the coupler strikes the ends of the draft timbers. This was referred to letter ballot as a standard.

The second general division of the report was directed toward more complete definition of the contour lines when worn. Gages were submitted for this purpose and they were referred to letter ballot as recommended practice. The secretary was authorized to have gages made by a reputable manufacturer and submitted for approval to the association.

The third general division contained specifications for couplers which will be found in abstract in this issue. These were adopted entire as recommended practice. It was thought advisable to test them in service before being adopted as standard.

The question of establishing the dimensions of the shank of the coupler was referred back to the present committee for further report. The consideration of the dimensions of the shank was referred to the committee for report, with recommendations, next year, and the suggestion that the back corners of the yoke in the pocket attachment be changed from a radius of $\frac{1}{4}$ inch to $\frac{5}{8}$ inch, was adopted, while the remaining recommendation to provide play at the shank of the coupler in the carry iron of not less than $\frac{1}{2}$ inch on each side was submitted to letter ballot as a standard.

Committee to Test Couplers.

Mr. Waitt then moved "that the association appoint a committee on coupler tests, to consist of not less than five members, to whom shall be submitted from time to time the testing of couplers, the committee to certify to the association those couplers that had satisfactorily passed the requirements of the standards of the association and the recommended tests. Furthermore, that this committee be authorized to arrange for construction of standard machinery for testing couplers, the same to be paid for by the association."

This important motion was thoroughly discussed and Mr. Waitt made the following remarks: "I think this subject of couplers, as well as that of brake shoes and triple valves, is of enough importance to warrant a standing committee, and having such a standing committee we should furnish them with the necessary authority and facilities for carrying out their work so that we may have a permanent benefit from it. The railroads of the country want to know on the subject of couplers what can be safely used. The tendency is to introduce devices which are cheap, and we are likely to establish quite a number of additional requirements in connection with the standard coupler, and we are likely to introduce this recommended practice for tests and specifications. It is not for many of the railroad companies represented in the association to carry on and make investigations and tests in the same way that the larger companies can, and we want to distribute the benefit of this association to all roads represented. By appointing this committee and having them make tests of couplers submitted to them, we can ask the manufacturers of couplers if they have had their coupler tested and passed. We shall be informed of those which have passed and of those which

have not passed, and we would be justified in refusing to use couplers that have not passed the tests. In that way the number of different couplers will be reduced."

The effect of this action will be to permit of weeding out poor couplers by depriving them of the sanction of the association. The discussion was closed by ordering that the standing committee on couplers should suggest a method of marking couplers to show the length of service in a way similar to that employed on air brake hose.

Air Brake Appliances.

Mr. Rhodes considered the recommendations of the committee important and suggested taking them up for letter ballot as recommended practice. The first six were ordered submitted. Mr. Rhodes then moved the appointment of a committee to confer with the air brake companies with regard to a further recommendation for the adoption of the recommended practice. The present committee was continued for this purpose.

Wheels and Axles.—Specifications for 60,000, 80,000 and 100,000-Pound Cars.

The committee submitted specifications for 33-inch cast-iron wheels, which were ordered submitted to letter ballot for recommended practice.

The axle for 38,000-pound cars recommended by the committee was criticised by Mr. Sanderson because, when the journals are worn, their length being 1 inch greater than the journals of the 80,000-pound axles, they could not be utilized in cars of lighter capacity. Mr. Higgins did not believe it wise to take chances in regard to strength and to sacrifice safety and satisfactory operation for the purpose of saving money in repairs, and this view prevailed. The design was ordered referred to letter ballot for recommended practice. The specifications for steel and iron axles were disposed of in the same way and the association voted to use numbers to designate the different standard axles instead of the dimensions of the journals, as is now generally the case.

Uniform Sections for Car Sills.

The purpose of the report was to show that by standardizing the sizes of sills better lumber and more prompt delivery could be secured from mills and car building companies. Mr. Barr suggested that the work should be extended to include siding and roofing, and it was stated that the committee on subjects for the next convention had provided for this. The recommendations of the committee were ordered submitted to letter ballot as a standard.

Height of Couplers.

This report was received and the committee discharged, as no other action was necessary.

Committee on Subjects.

The report of this committee was as follows: Standard center plates; Draft gear, Standard spread for side bearings; Air brake hose specifications; Uniform sections of car siding and car flooring; Design of journal box, box lid, bearing and wedge for cars of 100,000 pounds' capacity; Dead blocks; Safety chains.

The election of officers resulted as follows: President, C. A. Schroyer; 1st Vice-President, J. T. Chamberlain; 2nd Vice-President, W. J. Robertson; 3rd Vice-President, J. J. Hennessey; Treasurer, G. W. Demorest; Executive Committee, S. P. Bush, A. E. Mitchell, Wm. Garstang; Secretary, J. W. Taylor.

For places for holding the next convention, Detroit, Saratoga, Cleveland and Alexandria Bay were suggested and the matter was left with the executive committee.

The convention adjourned at 12.30 P. M., June 16.

Brief and active topical discussions, with a short time allowance for each subject, are exceedingly valuable in the deliberations of a technical association. The list of subjects is not always completed and the action of the M. C. B. Association this year in ordering the introductory remarks for those which were omitted in the meetings to be printed in the proceedings is to be commended in order that the preparations for their presentation shall not be lost.

THIRTY-SECOND ANNUAL CONVENTION.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

The convention opened with prayer by Chaplain Charles S. Walkley, of the United States military post at Fortress Monroe. The opening address was delivered by the Hon. Joseph Bryan, President of the Richmond Locomotive Works. After referring to the historical interest of Old Point Comfort, the vital influence of transportation in improving the commercial and social condition of the country was commented upon, particularly in unifying the people of the United States. The speaker gave an account of the purpose and plan of the International Railway Congress. The importance of railroad transportation rendered the deliberations of this organization of exceedingly great value, and it was hoped that this country would be represented by a larger number of motive power men in the congress in Paris next year than was the case in London in 1895. The early history of the locomotive was presented in an interesting way, which led up to the recent recognition of the superiority of American designs, as indicated by orders received from foreign governments. An English view of the effect of this was a tendency toward the revision of practice there on a common sense basis, which would permit builders to have the advantage of uniformity. The address was interesting and well delivered.

Mr. W. S. Morris, Superintendent of Motive Power of the Chesapeake & Ohio, replied briefly with comments upon the remarkable advances of the past few years in the development of powerful locomotives which made the use of standards very difficult. Something should be done to eliminate unnecessary novelties in designs, and closer relations between the master mechanics and the locomotive builders with this object in view were desirable.

Mr. Quayle then read his presidential address. The condition of the association as to membership and finances was very satisfactory. The address was thoughtful, dignified and suggestive. It contained allusions to the war and the part played by the motive power men. The fact that they contributed in getting Admiral Dewey's ammunition across the continent and to Hong Kong three days before his departure for the historical victory at Manila should be a source of encouragement in days of drudgery. The marked advances during the year in increasing the power of locomotives received thoughtful consideration with regard to the savings thus made possible. By increasing train loads from 1,500 to 2,100 tons on grades of 6-10 to 7-10 per cent. not less than one-half the cost of the heavier engines required to do this work ought to be saved each year. The saving was to be had in the better use of fuel and in the reduction in wages. The compound locomotive had gained many friends during the year and was now no longer "in the balance." Shop arrangement needed more attention, particularly with reference to the possibilities of extension to meet increased demands. The address was admirable and we shall refer to it again.

The report of the secretary showed the association to be in a very satisfactory condition, the membership now being 653, the greatest in its history. There were no funds in the hands of the secretary, the expenditures being equal to the receipts for the year. The treasurer reported the receipts and expenditures and stated that the balance on hand was \$3,116.96.

The time for holding the next convention was discussed on the lines of the action taken by the Master Car Builders' Association. The matter was referred to the executive committee with power to act in conjunction with the executive committee of the other association. It is therefore assured that the two conventions will be held in one week next year.

Messrs. R. A. Smart, S. L. Kneass and Clement F. Street were elected to associate membership.

The association passed a resolution expressing the appreciation of the work of the Master Blacksmiths' Association and pledging co-operation in their efforts toward improvement. The same action was taken with reference to the Master Car Painters' Association.

Topical Discussions.

Subject No. 9.—"The comparative efficiency and economy of metal flexible joints vs. rubber hose for steam connections," was introduced by Mr. A. W. Gibbs, who stated that the oil thrown by driving wheels had seriously affected the usefulness and life of hose connections between engines and tenders. Metallic tubing with flexible joints were successful in overcoming this difficulty. The cost was greater but the benefits in avoiding failures were sufficiently important to warrant it. Mr. Frank Slater supported Mr. Gibbs' opinion and the only trouble he had experienced from wear had been overcome by locating the conduits nearly in line with the center of the draw connection. Mr. Manchester had used these connections with good results in carrying high-pressure steam from locomotives to baggage cars for electric lighting engines. About eight hose connections were required per year, while the pipe conduits were guaranteed for three years' service. Mr. Johnson reported adversely. Wear and condensation were found to be a serious disadvantage of the pipe connection. The general opinion was decidedly favorable to metallic connections similar in principle to the form shown on page 376 of our issue of November, 1898.

No. 1.—"To what extent and with what success have the recommendations of the committee on exhaust nozzles and steam passages been adopted?" Mr. A. L. Humphrey had asked 30 members of the association for their opinion on the subject. The practice was becoming almost universal. The draft appliances were generally considered very important in influencing the economy of operation of locomotives in its effect of reducing back pressure and improving the draft. Mr. Quereau, in examining this question, had found differences of opinion. His own experience was favorable, no great gain in economy had been attained, but the use of larger nozzles was possible. Mr. Robert Miller spoke warmly in support of the Master Mechanics' arrangement of front ends.

No. 2.—"Has not the time arrived when air brake instructors can accomplish more by instructing those who maintain brakes how to maintain them, than to instruct those who use them how to use them?" Mr. R. W. Bailey presented the subject. Both those who use and those who maintain the brakes should be instructed. Mr. Deems believed it dangerous to "let up" on the care now given to the instruction of trainmen and enginemen. A member believed it necessary to improve in the character of men who maintain the air brakes or to take their work into the shops. Mr. Huntley (C. & O. Ry.), as an air brake inspector, had found it necessary to devote more attention to the maintenance men, who were always ready to receive information. Mr. Conger had found trains in which 60 per cent. of the brakes were defective, which pointed to the absolute necessity of better maintenance and the inspectors should be instructed more carefully. They were worthy of it and capable of improvement. Mr. Small (Southern Pacific) desired to see definite action on this question. He would have traveling engineers take a larger part of the instruction of the enginemen, which would allow the air brake inspectors time to devote to the repair men.

No. 4.—"When double headers are used on passenger or freight trains, is it good practice to cut out the brakes on the head engine, and does this comply with the requirements of the law?" Mr. T. R. Browne believed that it was advisable to give both engineers the power to handle the brakes. Mr. Quereau would cut out the driving wheel brakes of the forward engine and that engine should control the brakes. This discussion developed the fact that what was safe in one part of the country was not necessarily so in other parts, and it was considered to be ill advised that the association should put itself on record in such a matter.

COMMITTEE REPORTS.

A Research Laboratory Under the Control of the Association.

Mr. Henderson presented the report in abstract. Mr. Sanderson did not agree with the report as to the policy of placing the large number of special subjects requiring the work of specialists in the hands of a general laboratory. The members themselves should do this work because of the advantage to be derived from the conduct of investigations. They should themselves be specialists. Mr. Delano agreed with Mr. Sanderson and doubted the advisability of centralization of research work.

Mr. Barr thought that a research laboratory would be established in the future. It was perhaps too soon to establish it now and it was too large a subject to discuss at this time.

Mr. Henderson desired to have the subject kept before the association by the adoption of the resolutions reported by the committee.

These resolutions were passed and the subject is placed in the hands of the executive committee. Nothing was settled by the discussion and whether or not such a laboratory was needed was not decided. The prevailing opinion in the brief discussion seemed to be adverse to the whole plan.

SECOND SESSION.

At the reassembling of the association Captain Robley D. Evans, U. S. N., gave a characteristic address which stirred the audience to demonstration and gave each auditor additional reasons for pride in our navy, its officers and equipment.

COMMITTEE REPORTS.

Best Methods of Preventing Trouble in Boilers from Water Impurities.

Mr. A. E. Manchester presented the report, which was an exhaustive treatment of the subject. Mr. Small related his experience with the method of treating water in tenders by the use of soda ash, which, owing to the character of the water, was not successful. Excessive blowing down was necessary and foaming occurred. For his conditions the pumping station method was better; the cost of a station did not exceed \$1,500 and was found economical. The process was efficient and in every way desirable. Mr. Delano referred to the heating of feed water by exhaust steam to precipitate the lime salts. He did not, of course, approve of evaporation plants, where live steam was used, but thought that waste steam now thrown away at shops might be utilized for this purpose. Prof. Hibbard explained the importance of preventing oil from passing into boilers when feed water is heated by exhaust steam. Mr. Barr directed attention to the importance of closely watching the work of the men in charge of the boiler washing, without which success could not be secured. Mr. McKenzie spoke of the use of the blow-off cock with waters that were not treated. The blowing off should be done immediately after the completion of a run. The cocks should be opened long enough to blow down about 1½ gages of water. The feeding of oil into the boiler was meeting with success. Mr. McIntosh believed that the blow-off cocks should be used while the engine was running, because of the assistance derived from the rapid circulation of the water at such times the sediment could be removed in greater quantities. Perforated pipes had not given success in his experience. Mr. McKenzie explained that the best effect of perforated pipes was had when the number of holes was not quite large enough to give a perfectly free exit to the blow-off cock. The effect of this was to distribute the action of the pipe over a large space.

Relative Merits of Cast-Iron and Steel-Tired Wheels.

This report was introduced by Mr. Barr, who deplored the small number of replies to the questions of the committee, especially in view of the fact that many roads now possessed the necessary information to permit of comparing the service and security of wheels of both classes. The question was raised

as to whether the necessity for using steel-tired wheels for engine trucks did not constitute a charge that cast-iron wheels were less safe than those with steel tires. Mr. Barr replied, in effect, that cast-iron wheels were strong enough for all service except that of guiding the front ends of present heavy locomotives. Mr. Small raised the question of the effects of increased capacities of cars and the continuous action of brakes on mountain grades.

Mr. Hickey moved that the committee should be continued to report upon wheels under engine trucks and tenders and to consider the different weights of wheels to be used for these purposes. It was arranged to select five members for this committee, two being selected from roads having heavy grades.

TOPICAL DISCUSSIONS.

No. 10.—“Can the ordinary Marine Salinometer be used to advantage in Districts where Alkali Water has to be used, in order to avoid excessive Concentration and Damage to the Fire Box?”

Mr. Morris explained the use of this device for ascertaining the specific gravity of boiler water. It would not give information other than the specific gravity and in many cases the amounts of the destructive solids in boilers were too small to be measured in this way.

No. 5.—“Is the use of Fusible or Soft Plugs in the Crown Sheets of Engines advisable?”

Mr. McIntosh was of the opinion that these plugs were so dilatory in action and had so little effect on the fire as to be inefficient for the purpose intended. They were considered very unreliable. It was moved that it was the sense of the association that the use of fusible plugs in crown sheets was not conducive to the prevention of overheating of crown sheets. Carried.

No. 6.—“What Advantages are gained by the use of Piston Rods extended through the front Cylinder Heads?”

Mr. Soule referred to this practice as a result of the use of larger cylinders. There was no unanimity of opinion among railroad men or locomotive builders on this practice and the limiting size when it became necessary was not determined. Many believe that the extended piston rod would be necessary in the future, but the details needed to be studied. Mr. Quereau believed that the extended piston rod was advantageous and that with good packing and good lubrication the practice should be made entirely successful. Messrs. Slater and Gaines did not see the necessity for these rods because their experience had shown that cylinders did not wear on the bottom but on the top, and it was not clear why the piston should be held up. Mr. Sague expressed the opinion that extended piston rods should be used on cylinders of 19 inches and more in diameter, with a view of providing an easily renewable bearing for the weight of the piston in order to avoid the expense of frequently boring out cylinders. Mr. Delano referred to the increase of the bearing surface of the piston in the Class H 5 and H 6 engines of the Pennsylvania, illustrated in the *American Engineer*, June, 1899, page 182, as a good method for providing additional bearing surface without the use of extended rods.

Resolutions were passed expressing the regret of the association that Mr. Cloud was obliged to decline re-election as secretary on account of going abroad, and voicing the sentiment that he had the good wishes of the association in his absence from this country. Mr. Cloud replied briefly and gracefully.

COMMITTEE REPORTS.

Advantages of the Ton-Mile Basis for Motive Power Statistics.

Mr. Quereau offered a resolution as follows: “Resolved, That it is the opinion of the association that the ton-mile basis for motive power statistics is the most practical method of comparison of results and that it encourages economical methods of operation and that it is desirable that the heads of motive power departments should urge its adoption by their

managements.” The committee was continued for further investigation during the year.

The discussion did not bring out more information than was given by the committee, but it was clearly the opinion that great care should be given to the methods of comparing the service of men in order to secure fair conditions. The importance of the subject appeared to be thoroughly appreciated, as also was the fact that the motive power department was merely a part of the road and not an organization with interests of its own, as it was too often considered formerly.

CLOSING SESSION.

This session opened with resolutions providing for a committee to report each year upon how generally the standards of the association are used by the members and one to report next year upon “How the association can improve its usefulness.” The latter committee was appointed in response to a suggestion contained in the address of the President.

COMMITTEE REPORTS.

Best Methods of Applying Stay Bolts to Locomotive Boilers.

Mr. Higgins offered an additional reason for drilling instead of punching tell-tale holes in stay bolts. Experiments on a vibration machine had shown drilling to be far superior to punching in its influence on the strength of the stay bolts. Mr. Soule stated that the practice of the Baldwin Locomotive Works had been changed from punching tell-tale holes to drilling them, but the holes were drilled before putting the stay bolts in place. Mr. Slater approved of drilling stay bolts in the shop, because of the difficulty in getting the holes central with the bolts when the work was done after the bolts were placed in the boiler and riveted up. Mr. McConnell had drilled stay bolts in the shop for several years. Mr. Gillis spoke favorably of the use of dies instead of lead screws for threading stay bolts. Mr. Soule differed with Mr. Gillis as to the accuracy of dies for thread cutting. He preferred positively the lead screw because the correctness of thread depended largely upon the accuracy of the size of the rough stock. Mr. Gillis replied by quoting experience supporting his previous statement. Mr. T. R. Brown had carefully investigated the whole question and found it advisable to use an accurate lead screw for making the hobs and did not use the lead screw directly. By daily comparisons with a gage the threads were kept in correct condition. He had investigated the steels for taps and by ascertaining the amount of change in hardening this effect could be provided for. He made his own taps and could make more accurate ones than he could buy. Mr. Atkinson placed himself on record as disapproving the use of tell-tale holes because of their weakening effect at the failure point of the stay bolts. Mr. Gaines believed that the holes actually strengthened the bolts.

Flanged Tires on Driving Wheels.

Mr. McConnell reported the use of all flanged tires on a number of important roads. On the Union Pacific no plain tires have been put on consolidation, ten-wheel or switch engines for several years. On consolidation engines the tires of the two middle pairs of drivers were set 3-16 inches closer together than the others. With this practice the wear of the flanges of the other wheels was less than before. The Baldwin and Brooks Works used flanged tires on all engines of these types when not otherwise ordered, but the other builders had not adopted the practice to that extent. It was important to save the expense of carrying two kinds of tires in stock. The general opinion was decidedly favorable to the use of flanges on all tires, with plenty of allowance for lateral motion of the axles between the boxes, but there was not by any means an undivided opinion on the subject. Mr. Quereau moved the continuance of the committee with instructions to secure information with regard to the effects of this proposition on the track because of the danger of getting into trouble with excessive play on account of frog points.

Best Form of Fire Box to Prevent Leaking.

There was no report from this committee and the committee was continued to report next year.

Use of Nickel Steel in Locomotive Construction.

The report was presented by Mr. L. R. Pomeroy by request of the association.

Mr. H. F. J. Porter was invited to speak on the subject. He was interested to see that nickel steel should not receive a "black eye," such as steel in general had experienced in the early days because the metal was not understood. The heat treatment was most important and this was not generally understood. The report was ordered printed and the discussion postponed.

Square Head Bolts and Nuts and Standard Pipe Fittings.

Mr. Quereau presented the report and showed that it was probably not to be difficult to secure uniformity in pipe fittings. The report also interested the Master Car Builders' Association as has already been stated. Mr. W. H. Lewis moved the endorsement of the recommendation of the committee, which was to the effect that the association should adopt the Briggs standard as determined by the Pratt & Whitney Company's gages, as the standard of the association for wrought-iron pipe and couplings. This was carried. The report was really a joint one with the M. C. B. committee, but the work was divided, the M. C. B. Association considering the part concerning bolt heads, while the M. M. Association treated the pipe subject, but both committees joined in signing both reports.

Topical Discussions.

Subject No. 8.—"What can be done to thoroughly relieve the Vacuum in a Low-Pressure Cylinder of a Compound Locomotive when Drifting?" Opened by Mr. Sinclair.

Relief valves had been thoroughly tried and found unsatisfactory, chiefly owing to leakage. By-pass arrangements were efficient for the purpose and would probably be used quite generally in the future. Mr. Mellin reported favorable results with by-pass valves. Mr. Sanderson recommended the use of the throttle to pass a little steam into the cylinders when not working. Mr. W. S. Morris supported the favorable opinion of by-pass valves.

No. 11.—"Is it advisable or not to use Bars in Exhaust Nozzles?"

The association passed a vote that its opinion did not favor the use of bridges or bars in exhaust nozzles.

Subject No. 12.—"Is there sufficient Prospective Economy to be derived from heating the Feed Water for Locomotives, and how can it be most reliably fed to Boilers?"

Mr. Garstang appreciated the value of heating feed water, but he did not see how it could be accomplished in any other way than to use the exhaust of air pumps and the waste steam from blowing off. The prevailing opinion was that feed water heating was not worth the trouble involved, but no one spoke on the subject in the light of recent experience, and the discussion can not be considered as conclusive or satisfactory.

Closing Business.

No recommendations as to the place of holding the next meeting were made.

The election of officers resulted as follows: President, J. H. McConnell; First Vice-President, W. S. Morris; Second Vice-President, A. M. Walcott; Third Vice-President, J. N. Barr; Treasurer, G. W. West; Secretary, J. W. Taylor.

The convention adjourned at 12.45 P. M., June 21.

The heating surfaces of boilers tested under the revised code for boiler trials, recently reported to the American Society of Mechanical Engineers, will be measured by the side of the tubes next to the fire. This will cause additional calculation, but it is the correct way to measure heating surface.

THE PRATT & WHITNEY COMPANY.

By M. N. Forney.

The striking object in approaching Hartford is the State Capitol building, which stands on an elevation in a park alongside the railroad. Not having seen all the other State capitol buildings in the country, a sweeping comparison with them would be unwise, but it is safe to say that this one is the most beautiful of the dozen which the visitor has seen. A remarkable fact about it is that it was built at a cost within the original estimates, and was completed within a reasonable time after its construction was commenced.

To reach the Pratt-Whitney works from this railroad station involves a walk through the grounds in which the capitol stands. It is well worth visiting and a traveler in New England would be repaid to stop over from one train to another to look at it.

Like many other similar establishments, that of the Pratt & Whitney Company has grown very much within the recollection of the writer. Their product is confined to the lighter class of machine tools and embraces a great variety. This article would assume the character of a catalogue if the different kinds which are made here were merely enumerated, so the specifications must be very general. Besides the ordinary tools and machines, such as lathes, drill presses, boring machines, gear-cutters, they make a great variety of screw machines. Of these it may be said, in the language of Herbert Spencer, that their evolution has been from the homogeneous to the heterogeneous, and instead of the comparatively simple appliances for making bolts which were employed forty or fifty years ago, in which all the operations were either performed or directed "by hand," we now have a complicated mechanism which acts automatically and performs the greatest variety of operations without any other attention than that of supplying the material required, and then start and stop the machine. We old fellows, who were apprentices half a century ago, can remember that one of the first "jobs" on which we were put at work was the centering of bolts, which were forged by hand. This was done with a center-punch, and the bolt was then revolved on two centers, and a piece of chalk was held so as just to touch the most prominent part of the bolt as it revolved. If this chalk marked all round, it indicated that the bolt was centered true, but if it was not, the chalk would mark on one side only, and would show which way the center should be moved. When the position of the centers was then established, the next process was to drill into each end of the bolt and then countersink the drill holes. The bolts were then put into a lathe and the ends cut off to the proper length and the heads faced on the tops and bottoms. The shanks of the bolts were afterwards turned, and they were sent to a "chasing lathe" to have the screws cut on them. The heads being forged by hand, were often sadly awry, and these were planed off true in a small crank planer, one side at a time, the bolt being held in centers and turned a quarter or a sixth of a revolution after each side was planed. The heads were then filed smooth and polished on a buffing wheel.

In a modern screw machine a long, horizontal or square bar of iron, according to the shape of the head, is fed into the machine through the spindle. Sufficient metal is cut away to form the shanks of the bolts, the screw is cut, the heads trued up and the bolt cut off the right length by a series of tools in a turret, which are successively brought into operation automatically. The Pratt & Whitney Co. make a great variety of such machines for the manufacture of all kinds of bolts, studs, pins and other parts used in machine construction. These are produced with the utmost precision, and their size is so accurate that they are absolutely interchangeable. It would take an elaborate treatise to describe these machines and their work, and much mental effort would be needed to understand the treatise, the writing of which will be indefinitely postponed.

But still another step has recently been taken in screw and

bolt machinery. When bolts are made out of a solid bar, there is, of course, much waste of material, as the original bar is the size of the head of the bolt or screw, and the bar must be cut away to form the shank. The improvements made in forging bolts have been so great that the heads are now formed of such accurate sizes that no finish is required and the shanks are made with an equal degree of precision. It is evident that if such bolts can be forged at a low cost, and if they can be finished in an automatic machine, that considerable economy will result. To meet this requirement what are called "magazine" machines have been produced. In these the forged bolts are placed in a receiver, which consists of a groove of the shape of a letter \triangleright , which receives the heads of the bolts. These are placed in the upper end of the groove and are taken out successively by the machine at the lower end. All the other operations are automatic, the tools being attached to a turret and are brought into operation successively at the proper time without any co-operation of the person who superintends the working of the machine. As long as the supply of forged bolts is maintained, the machine continues to produce the finished articles. An operator will superintend the working of a number of machines, and all he must do is to keep them supplied with the raw material in the form of forged bolts. These machines are, of course, very complex, but they do their work with wonderful accuracy and certainty, and at a cost which makes handwork an impossibility.

The Pratt & Whitney Company have made a great deal of machinery and tools for the manufacture of bicycles, but at present there is less activity in this line, owing to the failure of many establishments which were engaged in this new business, and whose appliances have been thrown upon the market.

It may seem remarkable to many of the younger generation of engineers and machinists that there could have been a time when each shop had its own system of screw-threads, and that it was rarely that a nut of any nominal size, made in one shop, would fit a bolt of the corresponding size in another. Nevertheless such a condition of things existed not so many years ago, and those of us who engaged in the propaganda of introducing the Sellers standard for screw threads often recall the struggle now with some satisfaction, knowing that the victory has been won. When action was first taken by the Master Mechanics and Master Car Builders' Associations, to adopt the Sellers standard, the Pratt & Whitney Company engaged in the manufacture of taps and dies, gauges and other tools of precision for the making of screws which would be interchangeable. Before that time there were no screws made in this country that were certain to interchange with any others. The standard gauges of the so-called U. S. screws did not agree with each other. In fact the Pratt & Whitney Company in the outset of their new enterprise found that there was no absolutely reliable standard of measurement in this country, so they started at the foundation, and procured several verified standard yards compared with the one in the Tower of London. Being sure of their ground in this respect, they next found it essential to make a dividing machine by which the yard could be divided into any number of parts, inches and fractions of an inch—with sufficient precision. Afterward they had to devise many kinds of tools and processes for the manufacture of taps and dies, so as to secure interchangeability of the screws made with them. A large amount of money was invested in the plant for this work, and it now forms an important branch of their business. At first one of the difficulties encountered was that the screws of nominal sizes in general use were in reality over size. That is a $\frac{3}{16}$ -inch screw was often $\frac{29}{32}$ in diameter, and a great many taps and dies were ordered oversize. Of course, as long as this practice prevailed interchangeability of screws was impossible. Gradually the public has been educated in this respect, and now the Pratt & Whitney Company say that only about 10 per cent. of the taps and dies, which they supply, are over-size, and the number of them which are furnished is steadily diminishing. Being a re-

former is not often a very happy existence, but it is a satisfaction to some of us who engaged in the crusade for standard screw-threads years ago to know that we won the battle.

Gauges of various kinds and measuring machines also form an important part of the product of this company. Another treatise might be written to describe what is done in this department, but that, too, is indefinitely postponed.

An interesting place is a large storehouse for the finished products of this establishment. In order to produce lathes, drill presses and many other tools and machines, at the lowest possible cost, it is essential that a large number should be made at one time. If this is done, unless ordered ahead of their production, some or all of them must be stored until they are wanted. Consequently this company has constructed a large storehouse near the shops, which now contains a large stock of the machines which they make—the stock on hand and that in progress amounting in value to over \$1,000,000.

There is much more of interest in this establishment—sufficient to make a considerable number of articles of this kind, but the length of this one compels me to end it abruptly.

TRANSPORTATION EXHIBITS AT PARIS IN 1900.

Mr. Willard A. Smith, Director of Transportation and Civil Engineering to the United States Commission, Paris Exposition, sends us the following information with regard to the arrangements which he has made for the department:

The exhibit of Civil Engineering and Transportation in the American section at the Paris Exposition promises to be very large and thoroughly representative. Owing to the nature of the exhibits and the character of the buildings, this department will be represented in several different locations. The exhibit of the Merchant Marine will be made in the Merchant Marine Building on the banks of the Seine. The principal features will consist of a large exhibit by the American lines and models illustrative of American yachting. Permission has also been secured to install in this building models of American naval vessels, and it is intended to show all of the most important battleships, which have become famous in the recent war. In the Palace of Transportation and Civil Engineering on the Champs de Mars will be located the carriage and vehicle exhibit. In the same location, on the ground floor and partly on the gallery, there will be an exhibit of Civil Engineering which will consist of models, maps and photographs, illustrating the engineering features of our great cities, transportation lines, etc. One of the most important of these exhibits will be a model some 20 feet in length, of the Chicago Drainage Canal. In connection with this will be shown models of all the great variety of excavating and conveying machinery used in this most important of recent works of this kind. These models will be shown in operation, and it is believed that this will be the best exhibit of an engineering character ever made at any exposition. The railroad exhibit, consisting of cars, locomotives, railway machinery and appliances of every kind will be made in the buildings provided for this purpose at the Bois de Vincennes, where all railway exhibits made by all countries will be located. There will be at least 16 American locomotives which, on account of their magnitude, will be very attractive to foreigners. The fact that our locomotive builders are now securing business in all parts of the world, including even France and England, gives this exhibit peculiar importance and significance at this time. Steel cars and other recent developments in American railroading will also be properly represented. At the Bois de Vincennes will also be located the bicycle and automobile exhibits. A space of 8,600 square feet has been secured for the American Bicycle Building. A track some two miles in length running around the Lake Daumesnil in the Bois de Vincennes has been provided for showing automobiles and motor vehicles of all kinds in operation. A space of 4,300 square feet in the automobile building has been secured for American exhibitors. At Lake Daumesnil will also be shown our steam, electric and gasoline launches in operation, as well as a live exhibit of life saving service and everything of that nature.

Actual allotments of space have not yet been made in the Transportation Department, owing to the fact that it has

been impossible to get a definite location and information regarding the same from Paris. Commissioner-General Peck, who is now in Paris, has been extremely successful and has secured a much larger amount of space than was heretofore deemed possible. All manufacturers of any material included under the general title of Transportation and Civil Engineering should at once make their application for space if they have not already done so.

WATER TUBES IN LOCOMOTIVE FIREBOXES.

London & Southwestern Railway.

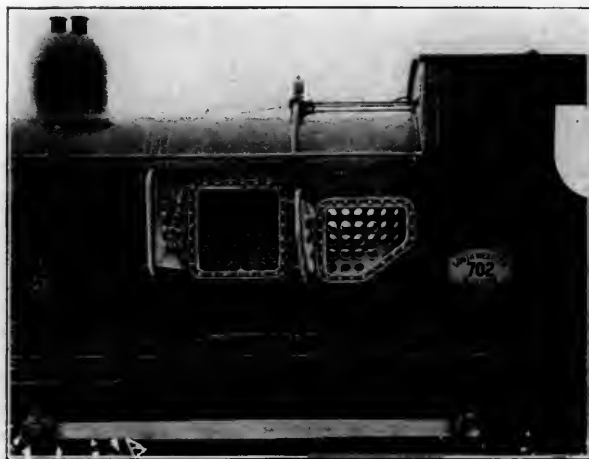
The accompanying engravings were made from photographs of what is known as the "No. 702 Class" of express locomotives on the London & Southwestern Railway which were received after our March issue containing the description of Mr. D. Drummond's practice with regard to firebox water tubes was

STEEL CARS AT THE CONVENTIONS.

The Pressed Steel Car Company exhibit at the Old Point Comfort conventions consisted of six cars embracing the practice of two years ago and the latest improvements. The present state of the art was shown by a new and very large hopper car for the Lake Shore & Michigan Southern. With a capacity of 110,000 pounds of coal or coke, the weight of the empty car is but 36,600 pounds, which is about one ton lighter than the Pennsylvania cars of the same type, and of slightly greater capacity. The Lake Shore cars have an improved door operating device which is entirely protected by being under the car, the only portion projecting from the side being the squared end of the shaft and the pawls for locking it. This device is much simpler than any previous arrangement and it is powerful because of the use of a large toggle joint. This and several



Locomotive with Water Tubes Across the Firebox.
London & Southwestern Railway.



Side View, Showing Ends of Tubes.

on the press. Mr. Drummond now sends these photographs and the following particulars:

Heating surface of boiler tubes	1,187 sq. ft.
" " firebox tubes	165 sq. ft.
" " firebox	148 sq. ft.
" " total	1,500 sq. ft.
Grate area	24 sq. ft.

It will thus be seen that the heating surface of the firebox tubes is a little more than that of the firebox itself. The boiler pressure is 175 lbs., and Mr. Drummond writes us that these engines maintain full steam pressure when the engines are working at their maximum capacity. The views show the appearance of the firebox tubes with the cover plates open and also the exterior of the engine with the covers closed and the jack-ets in place.

of the other cars were fitted with the McCord journal box and the trucks are of the diamond type of pressed steel.

The Pittsburgh, Bessemer & Lake Erie coal and ore car that was at the conventions two years ago appeared again this year, after continual service, and it is stated that it has been very severely used, although there are no evidences of deterioration. This car has the Schoen pressed steel trucks. Its capacity is 100,000 pounds of coal or ore and its weight is 34,350 pounds.

An ore car from the Monongahela Connection Railway of Laughlin & Co., which has hardly missed a day's service in 18 months, shows the ability of these cars to stand punishment. Its capacity is 100,000 pounds and its weight 28,800 pounds. Ore service is specially severe and yet the car appears to be in perfectly good condition.

The fourth was a 100,000-pounds capacity coal car from the Pennsylvania Company. Its weight is 38,300 pounds and after 18 months' service the only signs of wear are in the absence of paint on the inside of the car and the scars of the plates, which would be expected from the abrasion of the coal. The fifth was like the one just mentioned except that its capacity was 95,000 pounds. It had been used one year. The sixth was a Union Pacific gondola of 90,000 pounds' capacity, with four drop doors at the center. This car was built for coal, ore or coke. It weighs 29,900 pounds and has Fox trucks and the Buhoup three-stem coupler. The exhibit was in the charge of Mr. A. G. Glover and it offered the best possible opportunities to examine the pressed steel car situation, as it exposed the effects of from 15 to 25 months of service.

The "Railway Master Mechanic" changed permanently to magazine form with the appearance of the June number, which is 7 by 10 inches in size and in every respect an admirable improvement. It is specially noteworthy for the typographical work and engravings, as well as the quality of the paper and the excellent taste shown throughout. Typographically it is among the best publications outside of the art magazines.

Ancient American sleeping cars were commented upon by L. Xavire Eyma, a Frenchman, who came to this country in 1847, in an article in L'Illustration of Paris, published July 22nd, 1848, giving his experiences on the railroads of the United States. He said that at that time the Baltimore and Ohio Railroad had a length of seventy leagues and that the cost of the road was 4,116,744 francs, the receipts 3,983,456 francs and expenses 1,964,741 francs. He also gave considerable space to the interior arrangements of the sleeping cars used at that time and says that "they are actually houses where nothing is lacking for the necessity of life and are divided into compartments and sleeping rooms, some for men and some for women." Each room held six beds or rather little couches in three tiers along the sides. He winds up his account by saying that valuables were not particularly well taken care of, as in America there "were no such things as sneak thieves."

NEW WORKS OF THE BULLOCK ELECTRIC MFG. CO.

As an example of the advance which is being made in the large manufacturing establishments of to-day, attention is called to the new manufacturing plant of the Bullock Electric Manufacturing Company of Cincinnati, Ohio. There is no better example of a complete and modern plant in this country.

The new establishment was completed last summer, and was occupied the first of the present year. The buildings are located at East Norwood, Ohio, one of the suburbs of Cincinnati, which is less than five miles from the heart of the city. The B. & O. S. W. Railroad crosses the Pennsylvania lines at this point, and both roads have tracks entering the works, giving the Bullock Company excellent shipping facilities.

Perhaps the first impression received by the visitor to the works is the simple yet exceedingly attractive architecture of the several buildings; second, the great amount of light and general cleanliness within. The buildings are constructed of light buff pressed brick with appropriate trimmings of stone, and separated from each other by grass plots, flowers and shrubs.

It is difficult to think of anything which would facilitate and render more comfortable the pursuit of duty by officer, clerk or workman in the new plant than these light, airy and pleasant surroundings; and a vast amount of thought and care, not to mention expense, has been necessary in securing these results.

The plant comprises the administration building, machine shops, foundry and power house.

In the first of these are the general offices, drafting and pattern rooms, lunch room for officers and heads of departments, with a complete equipped kitchen and pantry, general lavatory and locker rooms for workmen.

The dressing room section set apart for mechanics and shop employees is not only provided with the usual toilet arrangements for the men, which are thoroughly modern in every detail, but there is also a complete system of lockers and baths. Each man has a locker under key placed at his disposal, and in the lavatory are set bowl, shower and needle baths.

The machine shops of the Bullock Works are interesting as illustrating the great economic progress made in manufacturing methods. There are no long lines of shafting and counter-shafting; no belts; each machine in the Bullock Works is driven by an independent Bullock electric motor, which absorbs power from the transmission lines only when it is required.

Among the machines equipped may be mentioned cranes, power presses, lathes, planers, drills, milling machines, profilers, emery grinders, hydraulic presses, boring mills, etc. The motors used for driving these various tools are designed and adapted for the tools mentioned, and are built into the headstocks of lathes, while in other tools they take the place of the driving pulley and require no additional room. The motors are of the Bullock slow-speed type with the variable speed control governed by the Bullock multiple voltage system. The tools may be operated in six varying speeds in either direction, without the use of back gearing or any resistance in the electrical circuits.



Machine Shop.



Machine Department.



Bullock Belted Motor.

The power house is provided with vertical water tube boilers, equipped with automatic stokers. A cross compound engine direct connected to two of the Bullock Electric Manufacturing Company's engine type generators, supply current not only for the lighting system, but for the Bullock multiple voltage power transmission system used throughout the entire plant. An elaborate switchboard has been erected with the necessary electrical instruments and switches, including recording wattmeters registering the amount of power being used on the various circuits. A section of this building, occupying the whole southerly end, is set apart and fitted out for the employees' lunch room. Apparatus for heating the general machine shops is located in the basement of the power house, and hot air is conveyed hence underground to its destination.

Altogether the plant is a notable one, and one which is worthy of a visit from any manufacturer contemplating a change of power or material reconstruction of shops of any kind. There are many large plants in the country, but the Bullock Company may safely assert that there are none more nearly up-to-date in equipment, from a manufacturer's point of view.

The officers of the Bullock Electric Manufacturing Company are: George Bullock, president and treasurer; J. S. Neave, vice-president, and James Wilson Bullock, secretary.

The lack of uniformity in the details of M. C. B. couplers of various makes has given rise to a great many suggestions for improvement, of which those summarized as follows are the most sensible we have seen: The so-called "vertical plane" idea does very well, the difficulties, which have now become rather serious, being due to the fact that there are over one hundred makes of couplers in use, in which there are slight but important differences, both as to contour and construction. Much as it is to be desired there is no hope of securing a single standard coupler, and the best that is to be done is to require sufficient uniformity so that couplers will work together, and then to make specifications as to strength and operation rigid enough to weed out unsatisfactory designs. This may be done by purchasing on specifications calling for the desired strength of material and including proper drop tests. Accurate agreement with the established contour lines is absolutely necessary. It is not sufficient that the limit gauge should be introduced, but the lines should coincide with the M. C. B. lines when referred to the center line through the coupler shank. The guard arm needs attention, and its outline should be continued at least three-quarters of an inch beyond the present limits. Nothing is more important in connection with couplers than service records showing where and why failures occur, and from which comparative wear may be obtained. The pivot pin hole should be located positively and greater accuracy of fitting should be urged. The lock should be positive and so made that it will not jump or crawl open in service, and the most thorough tests of this part should be made before putting the devices in service, in order to avoid flooding the country with unsatisfactory ones. The contour lines appear to be satisfactory, but there is need of defining the guard arm at the point and also for locating the entire contour with reference to the center line of the shank. These suggestions were reported by a committee of the Western Railway Club at a recent meeting. To this we would add that railroads should be prepared to pay a proper price for good couplers. The recent action of the M. C. B. Association covers this ground almost completely.

Large freight cars, 38 feet 4 inches long, are being built by the Caledonian Railway (England). The first lot have been completed and have entered service in carrying coal for the locomotives of the road. The cars carry 50 tons and the plan is an experiment from which the advisability of building larger cars will be judged. The possibilities may be seen by the fact that one of these large cars will accommodate the loads of seven of those in general use on the road in the same service.

FREIGHT LOCOMOTIVES, MIDLAND RAILWAY, ENGLAND.

Built by Schenectady Locomotive Works.

The Schenectady Locomotive Works have sent us photographs and information concerning the much talked about mogul freight locomotives which have just been completed for the Midland Railway, England. The design is essentially in accordance with American practice and but for the six-wheel tender, the copper flues, staybolts, firebox and a few minor details, the engines would look "at home" on one of our roads. The long taper sheet in the boiler attracts attention and also the cab. The latter feature will probably be appreciated by the locomotive crews for the protection it affords. The limitations imposed upon the width of English locomotives by the narrow clearances are clearly seen in the flattened cylinder casings. It is customary to flatten the castings of the low-pressure cylinders of American two-cylinder compounds when the diameters approach three feet, but a good idea of the difficulties on English roads is given by the necessity for doing this with 18-inch cylinders. The reports of service records of these locomotives, if they are made public, will offer subjects for advantageous study on both sides of the water owing to the possibility of comparing methods of construction. We hope the results will be available. The chief dimensions of the locomotives are given in the following table:

General Dimensions.	
Gauge	4 ft. 8½ in.
Fuel	bituminous coal
Weight in working order	107,000 lbs.
Weight on drivers	89,000 lbs.
Wheel base, driving	15 ft. 6 in.
Wheel base, rigid	15 ft. 6 in.
Wheel base, total	23 ft. 0 in.
Cylinders.	
Diam. of cylinders	18 in.
Stroke of piston	24 in.
Horizontal thickness of piston	5¼ in.
Diam. of piston rod	2½ in.
Kind of piston packing	cast iron
Kind of piston rod packing	United Kingdom
Size of steam ports	16 in. x 1½ in.
Size of exhaust ports	16 in. x 3 in.
Size of bridges	1½ in.
Valves.	
Kind of slide valves	Allen, American
Greatest travel of slide valves	5 in.
Outside lap of slide valves	1 in.
Inside lap of slide valves	line and line
Lead of valves in full gear	1-16 in.
Kind of valve steam packing	United Kingdom
Wheels, Etc.	
Diam. of driving wheels outside of tire	60 in.
Material of driving wheel centers	cast steel
Tire held by	1½ in. and ¾ in. screws between spokes
Driving box material	cast steel
Diam. and length of driving journals	7½ in. dia. x 8 in.
Diam. and length of main crank pin journals	5 in. dia. x 5 in.
Diam. and length of side rod crank pin journals	front 4½ in. dia. x 3 in.; back 4½ in. dia. x 4 in.
Engine truck, kind	2-wheel swing bolster
Engine truck journals	5½ in. dia. x 9 in.
Diam. of engine truck wheels	36 in.
Kind of engine truck wheels	cast steel spoke
Boiler.	
Style	extended wagon top
Outside diam. of first ring	54½ in.
Working pressure	160 lbs.
Material of barrel and outside of fire box	Worth "Basic" steel
Thickness of plates in barrel and outside of fire box	¾ in., 9-16 in., ½ in., ¾ in.
Fire box, length	72 in.
Fire box, width	31¾ in.
Fire box, depth	74½ in.
Fire box, material	copper
Fire box plates, thickness	¾ in.; crown, ½ in.; tube sheet, ½ in. and ¾ in.
Fire box, water space	4 in. front, 3 in. sides, 3 in. back
Fire box, crown staying	crown bars 5 in. x ¾ in. welded at ends
Fire box, stay bolts	copper, 1 in. dia. 11 thd's
Tubes, material	copper
Tubes, number of	244
Tubes, diam.	1½ in.
Tubes, length over tube sheets	5 ft. 0 in.
Fire brick, supported on	studs
Heating surface, tubes	1128.87 sq. ft.
Heating surface, fire box	126.46 sq. ft.
Heating surface, total	1255.33 sq. ft.
Grate surface	15.87 sq. ft.
Exhaust pipes	single high
Exhaust nozzles	4¼ in., 4½ in., 4¾ in. diam.
Smoke stack, inside diameter	16 in. at top, 14 in. near bottom
Smoke stack, top above rail	12 ft. 9½ in.
Boiler supplied by	2 injectors, Gresham & Cravens
Tender.	
Weight, empty	43,800 lbs.
Wheels, number of	6



Mogul Freight Locomotive—Midland Railway, England.
Built by Schenectady Locomotive Works.



Interior View of Cab.

Wheels, diam. 50 1/2 in.
Journals, diam. and length 5 1/2 in. dia. x 9 in.
Wheel base 12 ft. 3 in.
Tender frame steel plate
Tender trucks wheels on axles in pedestal boxes
Water capacity 3,250 imperial gallons
Coal capacity 6 (2240 lb.) tons
Total wheel base of engine and tender 43 ft.

PROGRESS IN PINTSCH GAS LIGHTING.

A report recently prepared by the Julius Pintsch Co. of Berlin, shows in detail the number of cars and locomotives which have been equipped with Pintsch gas lighting on the railroads of a large number of countries, and including statements with regard to gas buoys and Pintsch gas manufacturing plants.

The report shows that there are 90,890 cars, 3,650 locomotives and 892 gas buoys and beacons using this system, with 303 gas plants for making the gas required for them. It also states

that the Midland Railway (England) has 2,454 cars fitted with this system, and operates 9 gas plants; also that the London, Brighton & South Coast has 1,647 cars so equipped, requiring 5 Pintsch gas works. It is stated that these are specially mentioned because these two roads were the first in England to experiment with electric lighting from the axle in 1890, each road had from 400 to 500 cars thus equipped, and the system was abandoned after several years' experience because it was found to be too expensive to maintain and too uncertain in operation. In this statement the conclusion is drawn that neither of these roads would have given up the electric system after so much expense in its development and adopted the Pintsch system, involving additional investment in equipment and gas making plants, unless it has been conclusively proved to be to their interest to do so.

A condensed statement drawn off from the complete report is presented in the following table:

	Cars.	Locomotives	Gas Works.	Buoys and Beacons.
Germany	34,325	3,566	71	98
Denmark	45	.....	3	21
England	17,800	.....	87	193
France	5,210	.....	22	188
Holland	3,012	5	9	58
Italy	1,522	.....	4	.....
Switzerland	371	2	1	12
Austria	3,111	.....	10	1
Russia	1,943	50	13	13
Sweden	379	.....	4	1
Servia	154	.....	.....	.....
Bulgaria	33	.....	1	.....
Turkey	103	.....	.....	.....
Egypt	2	.....	3	112
Canada	20	.....	2	14
Brazil	967	31	1	31
Argentina	984	.....	10	.....
Chili	46	.....	1	.....
India	6,458	.....	10	.....
Australia	1,000	.....	3	29
United States	13,405	.....	48	121
Total	90,890	3,654	303	892

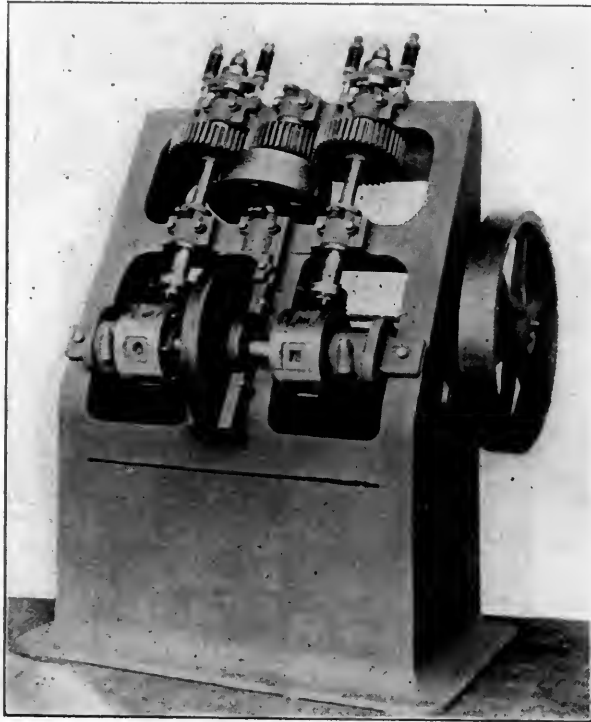
AN ATTACK ON MERCANTILE AGENCIES.

A bitter complaint against the old established mercantile agencies was made at the recent Buffalo meeting of the National Association of Credit Men. The committee on the improvement of the Mercantile Agency included the following in a set of resolutions forming a part of its report:

Resolved, That the National Association of Credit Men in convention assembled records its dissatisfaction at the disregard which has been paid by the old agencies to the suggestions for the improvement of their service offered by the delegated committees of this organization, and further records its belief that if a continuance of this same spirit of independency and inattention as to reasonable requests is continued the time will then be ripe for the development of a new agency, the policy of which shall be accuracy in reports and a constant endeavor to comply with the suggestions of practical credit men as to what is important and desirable in agency reports and service.

BURDICT NUT BURRING MACHINE.

This is a new machine which is much needed in the manufacture of nuts. It is designed to burr hexagon and square nuts from one inch in size down through the smaller sizes. The photograph shows the construction and the positions of the nut cylinders and the cutters. The machine is intended to be operated by two boys, who place the nuts in the nut holders. The cylinders carry them under the knives and rise automatically to the knives. When the burrs are taken off the



The Burdict Nut Burring Machine.

nut is dropped, carried around and discharged from the cylinder. The knives are flat and are easily ground, and the form is such that they are also easily made for replacement. It is obvious that the operators' fingers are not in danger of contact with the cutters because the nuts are inserted in the sockets before they are brought near the cutters. It is stated that the repairs to these machines do not amount to \$5.00 per year. Further information may be obtained from Mr. O. C. Burdict, White Building, Buffalo, N. Y.

COMMUNICATIONS.

VARIETY IN LOCOMOTIVE DESIGN.

Editor "American Engineer":

In making a comparison of locomotives of a similar type, the most striking thing to attract attention is the numerous and various methods resorted to in order to get locomotives of practically the same power, constructed so widely different in important details. For example, a certain combination of cylinders, pressure and wheels, with heating and grate surface known to fill the requirements, will be given an engine, and to all appearances the experiment is a successful one. Some other designer will create a machine for exactly the same service and there will be nothing in common between the two engines. One may have its power based on a high boiler pressure, a small cylinder with long stroke and comparatively large wheel, the other may have a larger cylinder with shorter stroke, the same boiler pressure and larger wheels. These factors may be so manipulated as to give identical results as to power, but there may be, and often is, a strong dissimilarity in the economy of their performance. This point is open to comment as reflecting

discredit on some features of design that cannot by any stretch of imagination be classified as correct. The relation of stroke to cylinder diameter is not as well defined as many other locomotion proportions, and on that ground diversity in those details may be expected, but the query, why there should be such a difference in practice on matters now clearly understood in their effect on locomotive economy, is one that will strike most mechanical men as a pertinent one. RONALD HAYDN.

BURNISHED FINISH FOR JOURNALS.

Editor American Engineer:

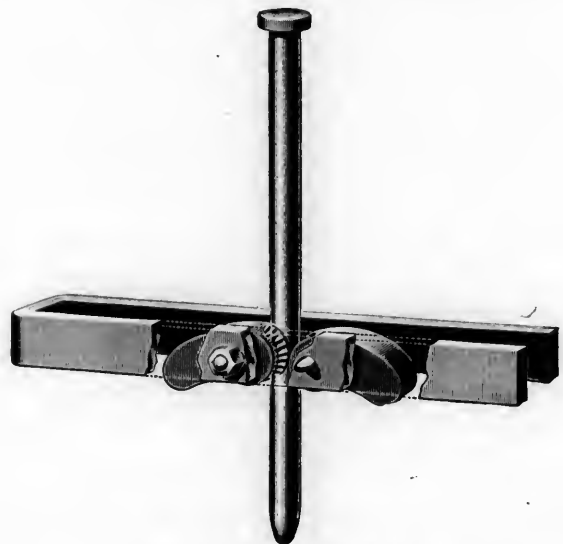
Your paragraph at the bottom of page 157 of your May issue, relative to the matter of invention of burnished journals, is correct. So far as I know, this roller was designed by myself at this shop. Formerly we had a great deal of trouble in attempting to get our journals smooth. We had tried all the schemes imaginable or known to the art to get a smooth surface. It occurred to me one day as I was standing near the lathe where we finish the journals, that probably a burnisher would put the required surface upon the journal. I told the man who was running the lathe to the brass lathe to get a burnisher, had him put the rest in the lathe and attempted to burnish the journal. I found that it was possible to do it, and then suggested that he make a roller and try it; and from that idea the plan of rolling car journals in order to get them smooth has been adopted very nearly over the world.

Missouri Pacific Ry.,
St. Louis, May 5, 1899.

L. BARTLETT,
Master Mechanic.

THE PEARSON KING BOLT CLAMP.

This is a simple device designed for use in wrecking operations when it is desired to clamp the trucks to a car in order to lift them together. The clamp has a U-shaped frame with two grips or cams pivoted at the proper distance apart to seize the king bolt and permit of lifting the truck by it. The king bolt is lifted out of the bolster and the clamp inserted under the bolster and lengthwise of the car, the space for the bolt being under the bolt. Then when the bolt is dropped into place the



Pearson King Bolt Clamp.

cams close upon it on account of the weight of the overhanging ends, and the truck may be lifted with the bar. This is a better and quicker way than chaining the trucks to the car body. In chaining freight car trucks it is often necessary to cut holes through the floor, and in such a case this clamp will save time and trouble. It is easily applied and it offers the additional advantage of holding the truck springs in place. The device is made by the Pearson Jack Co., 64 Federal St., Boston.

SUPPRESSION OF SMOKE.

Under the above title Dr. R. H. Thunston contributes an article to "Science" printed recently, in which he reviewed the status of smoke prevention both here and abroad, citing St. Louis as having been as successful as any other city in this country in reducing the smoke nuisance, and attributing the good results attained to the co-operation of the city government, the Board of Trade and the scientific men and leading engineers of that city. The recent discussions at Philadelphia under the auspices of the Franklin Institute (Journal Franklin Institute, June, 1897) were also referred to as having thrown much light upon the subject, and affording many valuable facts and data.

The author also said: "We have now the published results of another and formal investigation by a commission organized at Paris, composed of MM. Hurt, Brull, Hirsch, Humboldt, Lamouroux, Michel-Levy and De Tavernier, all holding important positions in the municipal administrations, or in the great schools of mines and engineering, or as leading members of the Society of Civil Engineers. The commission was in session at intervals from June, 1894, to October, 1897. It made a study of reports upon the subject, conducted important experiments, reduced them to order and studied out definite conclusions, and also investigated the origin, state and progress of the art, completing its report at the last named date. This document of over 150 pages is now in process of distribution.

The commission was to select acceptable forms of furnace and report to the city government for their license and use. The schemes of the 110 competitors include the following:

1. Mechanical feed and methodical combustion.....16
2. Supplementary injection of air, hot or cold.....20
3. Injection of steam, with or without air.....5
4. Stirring of the gases.....7
5. Gas producers and heating the gases.....7
6. Combustion of dust fuel.....2
7. Washing the smoke.....16
8. Various other systems.....37

The tests included rapid and slow combustion, and intensity of the smoke was observed and noted on a scale of five points; the usual methods of determining the efficiency of the apparatus being employed.

The history of legislation, as given, traced the progress of the subject in England from the time of Charles II., who, two hundred years ago, inaugurated repressive measures. In France, this form of legislation began with an imperial decree in 1810. Both countries now having well considered laws for suppression of smoke in cities. The technical history of the subject, curiously enough, begins with plans by Denis Papin. The next inventor to follow this illustrious man of science was James Watt, with his inverted draught, and later arrangement of dead plate. The automatic stokers, are referred to and their incidental but none the less effective, smoke reductions are described. Legislation now exists in all civilized countries, and many more or less effective devices and methods are in use for suppression of smoke.

Germany has also done some work in the line of investigation, a commission of distinguished engineers having been appointed by the Government in 1892, who, after prolonged experiments, concluded that success had not been attained, but that the way to success was clearly indicated.

The outcome of the French commission was the refusal to assign a first prize, awarding of two second prizes, of two first mentions and one second mention. The conclusions formulated indicate that the commission is not satisfied that a real success has been achieved, but nevertheless the researches were not without value. Like the German commission of 1892, it is concluded that the work of the commission should be considered only as a contribution to the study of smoke suppression, and it is to be hoped that these researches may continue. There remains much to be done, and a part of this collection of exhibits has very nearly attained the object proposed.

Among the specific conclusions are these:

Smoke cannot be suppressed without considerable excess of cost.

Special fuels, as anthracite, coke, fuel-gas and mineral oils, may be resorted to, and with success, where cost is not objectionable.

The chimney-top should be visible to the man at the furnace.

Prolonged trials should supplement such investigations as those prosecuted by this commission, to ascertain the durability of the apparatus and of its efficiency.

Existing legislation, well enforced, is advised, rather than any specific new legislation.

COMMUNICATION BETWEEN RAILROAD CARS IN ENGLAND.

A recent communication to the "Times," London, illustrates the importance of the establishment of a proper method of communication between the passengers and the "guards" on English trains, or what is better the provision of train valves for the application of the air brakes after the manner of the Westinghouse conductor's valves. All of the present troubles arising from the use of compartments without methods of communication seem to us entirely unnecessary and this danger of being roasted alive certainly should not be lightly passed over. The letter is as follows:

I yesterday had an ugly experience of the unreliability of the present system of communication by cord between railway passengers and the guard.

I came to London by the Scotch express, timed to reach Grantham at 4.23.

At about 3.45 a gentleman in the next compartment opened the communicating door, and called our attention to the alarming fact that the ceiling of the lavatory common to the two compartments was in flames. I immediately pulled the outside signal cord, which first stretched considerably, and then broke. I then pulled in the other direction, when the cord again gave way. I then went to the cord on the opposite side of the carriage, with the same result.

The cords were broken in four places, and there was no possible means of communication with either guard or engine-driver. In the meantime the other occupants of the carriage, five in number, devoted themselves to soaking towels and railway rugs in water, of which, happily, there was a supply in the cistern of the lavatory, and, by applying these to the flames, the spreading of the fire was arrested.

At last the supply of water came to an end, and soon after this the flames burst out in the cornice of the carriage adjoining the lavatory. This was a few minutes before we arrived at Grantham. The ceiling appears to have been of a material not very inflammable, and this, and the fortunate supply of water were the only factors in the case which prevented a most serious accident.

I may add that every effort was made to attract the attention of those at the stations we passed on the road, but without effect.

As the means of communication between passengers and guard are notoriously inadequate in this country, I do not apologize for asking space in your valuable paper, in the hope that it may cause some change to be made.

THOMAS WRIGHTSON.

Artificial draft produced by blowers not only permits of saving a large proportion of the cost of construction of chimneys, but also permits of burning cheap grades of fuel. Three Babcock & Wilcox boilers, rated at 355 horse-power each, at Central Falls, R. I., furnish power for a 1,500 horse-power Harris-Corliss compound engine. Cumberland semi-bituminous coal was used, because the draft was not strong enough for cheaper fuel. A mechanical draft plant was put in at a cost of about \$600, which made it possible to use a mixture of coal that cost \$2.29 per ton, which means a saving of \$6,500 per year in coal. This mixture included anthracite dust and buckwheat, with only 7 per cent. of Cumberland.

(Established 1832)

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street. London, Eng., Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.

The use of oil as fuel for forging furnaces was such a marked improvement upon solid fuels that oil furnaces have been introduced very generally and quite rapidly with satisfactory results. The immediate advantages gained were so great as to throw the matter of oil consumption somewhat in the background, because of the fact the most wasteful use of oil effected a marked saving over the most careful use of solid fuel. The time has now come, however, for the saving which may be effected by the best of oil burners, which consists in perfecting the methods for atomizing or "pulverizing" the oil. On page 195 of our June issue we printed a discussion of this subject, and in connection therewith it is interesting to note that the experience mentioned is corroborated in a paper by Sir Marcus Samuel, read before the Society of Arts (England) recently. The system described in the paper is based upon very perfect combustion of oil by air, which is supplied at a pressure of 50 pounds per square inch and heated to a temperature of 500 degrees F., by passing it over cast-iron plates in the furnace. For complete combustion it is found necessary that the oil be very finely sprayed on entering the furnace, and this, as we understand it, is the secret of the success of oil burning under marine boilers abroad.

The necessity for an occasional inspection of the sheets in the barrel portions of locomotive boilers was emphasized in one of the discussions at the recent meeting of the American Society of Mechanical Engineers. Prof. Forrest R. Jones told of a locomotive boiler, made in 1867, which exploded recently on account of grooving more than two-thirds through the sheets, which were of iron. Tests showed that the metal had an elastic limit of 24,000 lbs., an ultimate tensile strength of 45,600 lbs. and an elongation of only 2½ per cent. The plate could not be bent to an angle of 90 degrees without breaking, and it was evident that the preparation for destruction had been going on a long time. One of the inspectors of the Hartford Steam Boiler Inspection & Insurance Co. was quoted as saying that an inspection of the sheet ten years before the explosion would probably have shown a dangerous condition at that time. Another stated that it would have shown it five years before. These parts receive less attention than those which give more trouble, but they should be inspected.

Vacation work in railroad and locomotive building shops for students in railroad mechanical engineering at Cornell University is urged by Prof. H. Wade Hibbard in a pamphlet recently received from the author. We heartily commend the idea of urging practical experience for students, not only because of the educational advantages which it offers, but because of the value of coming into contact with hard-headed men and the opportunities which this plan affords for boys to gain the confidence of those who have succeeded in difficult work. A caution seems necessary, however, lest this vacation idea should lead young men away from the fact that a thorough knowledge of shop work is necessary to a proper foundation for successful practice.

The selection of wood in preference to steel for the construction of 50-ton capacity cars is surprising at this stage in railroad progress, yet one of the best of the railroad journals has just expressed the following opinion in regard to wooden box cars of this capacity:

"The choice of wood as a material of construction will strike some engineers as remarkable and calls for a word of explanation. After careful analysis it was found that a light steel car for 100,000-pound loads was practically out of the question. In tensile or bending strength, weight for weight, wood is the strongest material known in the arts."

If this is true the steel car is all wrong and a mistake has been made in building the pressed steel cars exhibited at several recent M. C. B. conventions, when new and after the severest kind of service, and which, but for the abrasion of paint, were as good as new. This position is astonishing and is a step backward, which has no support in recent experience with lightweight steel cars of large capacities. We have long been on record on the steel car question and it is not necessary to reopen a discussion that is considered definitely settled unless the words quoted prove to have more effect in favor of the wooden car than is expected. As to the relative strength for a given weight of wood and steel in tension or bending, no comment is necessary.

Among the improvements which are necessary with ordinary car equipment and more imperative with increasing loads and severity of service are those which will reduce the number of hot boxes and decrease the expense for bearings. The bearing now provided on car journals is limited in extent and it is most important that the load should be uniformly distributed and not transmitted to a point or a small portion of the bearing only. The load should be brought to the journal by some automatically adjustable connection which will insure a uniform pressure of the brass to counteract the effect of the tilting of the truck frames as in passing over low joints or around curves. To accomplish the uniform loading the brass must be sufficiently stiff to act as a girder and transmit the load without deflecting. The tendency is to increase the amount of metal in the brass to accomplish this result and this is a seri-

ous matter with the present high price of copper. The brass should be made stiff without unduly increasing the amount of bearing metal that is not essential to the bearing surface itself and its immediate support. The whole arrangement should be perfectly interchangeable with the M. C. B. standard in order to be satisfactory. If these conditions can be fulfilled in a bearing it ought to be successful. The concentration of loading by tilting the brass is undoubtedly the most frequent cause of hot boxes.

THE M. C. B. CONVENTION.

In an examination of the work of the recent convention of the Master Car Builders' Association several decisions stand out with special prominence. First, the provisions for improving the coupler situation; second, the adoption of a standard axle for 100,000-pound cars; third, the standardization of car sills; fourth, the settlement of the question of an allowance for the repairs west of the 105th meridian and, fifth, the re-arrangement of the time of holding the conventions whereby it will be possible to hold the Master Car Builders' and the Master Mechanics' Association in one week.

The coupler question is the most important now before the association and the action taken was based upon a report in which recommendations were made after a thorough study of the present conditions. They were conservative and practical, so much so in fact that the work of the committee was endorsed almost exactly as it was presented. The plan was to improve the coupler on the present lines and to provide for the weeding out of inferior and dangerous ones by the adoption of exacting specifications. To insure that couplers shall be correct in form when new and to provide against unsafe wear, excellent gages were adopted. The lines were unchanged except to extend the guard arm. This is all that can be done now and the conduct of the whole matter will undoubtedly give general satisfaction. The standing committee on couplers has important work to do and its appointment, as reported elsewhere in this issue, was a fitting conclusion to the transaction.

A standard "100,000-pound axle" was greatly needed because of the large number of cars of this capacity which are being built. The new design comes none too soon and if it had been attended to a year earlier nearly all of the large capacity cars might have been provided with journals of the same size. No time should now be lost in getting the standard into use.

A standard car of any capacity is a dream which, however desirable, we do not expect to realize completely, although a near approach to uniformity may be secured. An important step has been taken in confining the sizes of sills within limits, and as this work is to be extended next year, to the car sides and roofs, it is evident that there is a general awakening to the possibility of accomplishing that which might and should have been done years ago.

The allowance for the difference in cost of car repairs east and west of the 105th meridian was settled very quickly. It is a difficult question and one that must not be considered as a department question only. The revenues of the western roads have a great deal to do with it and the discussions of this year and last indicate the necessity for considering such questions from the standpoint of the railroad as a whole rather than as a matter concerning the department upon which the burden appears to fall.

Consolidation of the two associations appears to be as far away as ever, but the most important argument in favor of such action loses its strength when the two conventions may be held in the same week and the opening exercises are combined in one general session. The new order compels most careful selection of a place of meeting because it will mean that more people will be in attendance than in either week under the old arrangement. This clearly points to Saratoga as a desirable location, because there is no doubt of its capacity and comfort, and every precaution should be taken to insure the

success of the first convention under the new plan. Saratoga is most generally favored by those who attended the recent conventions.

THE MASTER MECHANICS' CONVENTION.

It is evident that the Master Mechanics' Association is not ready to endorse the plan of organizing a research laboratory such as was outlined in the report presented this year, and with further consideration it is probable that opinion will not grow to be more favorable in spite of the arguments that were brought forth by the able committee at the recent convention. The subject was too large to be grasped on short notice, and it is the opinion of many that it grows larger and more difficult all the time.

The treatment of boiler waters for the prevention of the formation of scale was very ably handled by a painstaking committee, and a great deal of information was presented in the report, but one of the most promising methods of improvement, the use of feed water heaters, was not given the place that it appears to have earned by its success in other branches of steam engineering. These devices claim attention not only because they heat the water, but also because they serve to prevent a great deal of the trouble with scale. They have been successful in this direction in France, as we shall soon be able to show our readers.

The cast-iron wheel had strong support from several speakers, and the opinion was expressed that for every service except that of guiding the front ends of the trucks of heavy engines the cast-iron wheel was equal in safety to the steel tired wheel. This, however, may be taken as a confession of weakness in the cast-iron wheel, although that was probably not intended. It may be asked why the specification of steel tired wheels for locomotive trucks is not at once an admission that this type is the safer of the two and why this does not constitute an unanswerable argument in favor of the use of steel tired wheels in locomotive and passenger service. It is evident from this discussion that the steel tired type is considered the stronger, because it is selected for the severest service.

The advantages of the ton-mile basis for locomotive statistics were generally admitted and it is probable that this idea will extend and that it will soon come into general use.

The form of stay bolts did not receive attention this year, the time being occupied in considering methods for preparing and applying them. This is the first time that so much attention has been given to methods for cutting threads on stay bolts, and it is now apparent that its importance is appreciated. The best opinion seemed to be that lead screws should be used as a final reference in making the dies and taps and that daily comparisons with correct gages should be insisted upon.

The practice of using flanges on all driving wheel tires of mogul, consolidation and ten-wheel locomotives apparently does not increase the resistance of the engines in passing around ordinary curves, and the advantage of saving the expense of carrying two kinds of tires of each size in stock is quite important. There seems to be a difference of opinion as to the possibility of doing away with blind tires altogether, but the opinion that this is possible seems to be growing. It is noticeable that none who have used flanges on all driving wheels of these engines have found trouble to result from so doing.

Nickel steel, while one of the important subjects, was disappointing in the discussion, for very little was said about it in the convention, and beyond knowing where to look for the literature of the subject, the association is not much wiser for having considered it. The one fact that was brought out in the convention was that it is most important that the heat treatment of nickel steel shall be better understood before it is used more generally. The proper ways to handle nickel steel in the shop should be considered by the association in time to prevent it from being charged with failures for which the material itself is not responsible.

Comments on other points brought out in the discussions are made elsewhere in this issue.

PERSONALS.

FRANK THOMPSON.

The death of Frank Thompson, President of the Pennsylvania Railroad, removes one of the best of American railroad men. There are few men of his ability and high, strong character, and his death is a national loss. His life was a brilliant example. It was one unbroken effort to conscientiously serve the Pennsylvania Railroad, the only employer he ever had.

Mr. Thompson was born in Chambersburg, Pa., in 1841. His father was a lawyer and judge. He was educated at the Chambersburg Academy and went directly into the Altoona shops, where he worked four years until called to the government service under Thomas A. Scott, then Assistant Secretary of War, in special charge of transportation during the Civil War. At the age of 20 years his work was to put the Orange & Alexandria and the Loudon & Hampshire roads into serviceable condition after the destruction by the Confederate army. This restoration extended to the city of Washington and gave the necessary rail communication to the capital. His next work was near Nashville, where he was equally successful.

Returning to the Pennsylvania in 1864 he was appointed Division Superintendent and in 1873 was made Superintendent of Motive Power at Altoona. About a year later he was appointed General Manager of the lines east of Pittsburgh and Erie; in 1882 he became Second Vice President, and in 1897 he succeeded Mr. Roberts as President.

One of his chief characteristics was a thorough knowledge, gained through experience, of the details of railroad management. He was a good executive and a shrewd and careful organizer. While a master of detail he fully understood the relations between small and large questions. He was intelligent, energetic and sympathetic. He possessed the ability to succeed in a position of great responsibility and few men leave more and warmer friends.

Mr. A. J. Cassatt has been elected to succeed the late Frank Thompson in the Presidency of the Pennsylvania Railroad. Mr. Cassatt was born in Pittsburgh in 1839 and completed his education at the Rensselaer Polytechnic College, Troy, N. Y., where he graduated in 1859 as a civil engineer. His first railroad experience was in the location and construction of a railroad in Georgia. In 1861 he became a rodman on the Philadelphia division of the Pennsylvania Railroad and two years later was made Assistant Engineer. In 1864 he was made resident engineer of the middle division. A little later he served as Superintendent of the Warren & Franklin Railroad, and in 1866 was appointed Superintendent of Motive Power of the Philadelphia & Erie at Williamsport. In 1867 he went to Altoona as Superintendent of Motive Power of the Pennsylvania. In 1870 he became General Superintendent and the following year was made General Manager of the road east of Pittsburgh and Erie. He was appointed Third Vice President in 1874, where he remained until 1880. Upon the election of Mr. Roberts to the Presidency in that year Mr. Cassatt became First Vice President and in 1882 he retired to private life. He was elected Director to succeed Mr. Samuel M. Felton in 1883 and two years later became President of the New York, Philadelphia & Norfolk, which position he now retains. He was appointed by President Harrison to the Presidency of the United States Commissioners to the Intercontinental Railway.

Mr. Waldo H. Marshall has resigned as Assistant Superintendent Motive Power and Machinery of the Chicago & North Western to succeed Mr. G. W. Stevens as Superintendent Motive Power of the Lake Shore & Michigan Southern, with headquarters at Cleveland. All of Mr. Marshall's work has been in connection with railroads and his success as a motive power officer is largely due to his experience, unusual insight into mechanical and business matters, combined with good judgment.

He served his apprenticeship in the Rhode Island Locomotive Works and with the help of an education, which he secured by his own efforts, he made such progress on entering the drawing room that he was put in charge of that department upon the resignation of the late David L. Barnes. After leaving these works Mr. Marshall was engaged in mechanical engineering work in New York, and soon after went to Chicago to take up editorial work on the Railway Review, after which for several years he was editor of the Railway Master Mechanic. In 1896 he was associated with Mr. M. N. Forney in editing the "American Engineer." In June, 1897, he received the appointment of Assistant Superintendent Motive Power and Machinery of the Chicago & North Western and in the two years of his service on that road he showed such ability as to place him among the ablest mechanical railroad officers of the country. Our readers know him so well that it is unnecessary to say more except to congratulate the officers of the road upon the selection of so valuable a man, and Mr. Marshall upon the appointment to this important position.

Mr. E. E. Davis has just been appointed Assistant Superintendent Motive Power of the New York Central in charge of locomotive work under Mr. A. M. Walcott. Mr. Davis has had a wide experience in which he has shown himself to possess unusual ability in the management of shops and men, the chief characteristic of his work being systematic organization on an economical commercial basis. He has been very successful in securing good work at relatively small cost and is a thorough student of methods of arranging shops and machinery to save unnecessary handling of material. Mr. Davis is 44 years of age. He was born in Durham, N. H., and after working a year in a blacksmith shop he learned the machinist's trade and took up tool making. Later he spent several years in the employ of the Newmarket Manufacturing Co. at Newmarket, N. H. His railroad work began in the shops of the Boston & Maine at Boston in 1881, where he soon became foreman, and in 1885 was made general foreman. He also performed the duties of draftsman at this time. In 1886 he left the road to enter manufacturing and returned the next year as Master Mechanic at Boston. From 1891 to 1895 he was Superintendent of the Boies Steel Wheel Co., and from there, at the request of Mr. Theodore Voorhees, he went to Reading as Assistant Superintendent of Motive Power of the Philadelphia & Reading, the position which he has just resigned to go to the New York Central.

Mr. F. W. Brazier has resigned as Assistant Superintendent of Machinery of the Illinois Central to become Assistant Superintendent of Motive Power and Rolling Stock of the New York Central & Hudson River Railroad, with headquarters in New York. Mr. Brazier, while a comparatively young man, has had a very wide experience of 21 years in railroad work. He began on the Fitchburg Railroad in 1878, after serving an apprenticeship in house building in Charlestown, Mass. He remained on the Fitchburg for 15 years, for eight of which he held the position of general foreman of the car shops at Fitchburg, Mass. In 1893 he resigned to become Superintendent of the C., N. Y. & B. Refrigerator Company at Elsdon, Ill., and in 1896 he was appointed general foreman of the car department of the Illinois Central at Burnside, Ill. In seven months he made himself so valuable to the company as to receive the promotion to the position of Assistant Superintendent of Machinery, which he now leaves. Mr. Brazier is admirably equipped for his new position and we are reliably informed that all his promotions have come to him unsought, his advancement having been due to recognition of merit. It is understood that he will have direct charge of the car department of the New York Central system under Mr. Walcott.

Mr. George W. Stevens, who has just resigned as Superintendent Motive Power of the Lake Shore & Michigan Southern, was born at Concord, N. H., in 1847. He entered railroad service

as an apprentice in the shops of the Lake Shore in 1861 and passed through the grades of fireman, locomotive engineer and machinist. In 1872 he was foreman in charge of locomotives and from 1873 to 1883 he was Master Mechanic. In 1884 he was appointed Superintendent Motive Power, which position he held until now. He is one of the best known motive power men in the country.

Mr. G. R. Henderson of the Schenectady Locomotive Works and formerly Mechanical Engineer of the Norfolk & Western Ry. has been appointed to succeed Mr. W. H. Marshall as Assistant Superintendent of Motive Power of the Chicago & Northwestern Railway. The appointment is pleasing to those who know how well Mr. Henderson has filled his previous positions, and Mr. Quayle is receiving many congratulations upon his selection.

Mr. D. C. Courtney has been appointed Superintendent of Motive Power of the West Virginia Central & Pittsburg Railway, to succeed Mr. B. O. Cumback, resigned.

Mr. R. F. Kilpatrick has been appointed Master Mechanic of the Morris and Essex division of the Delaware, Lackawanna & Western, at Kingsland, N. J., to succeed Mr. William H. Lewis, resigned.

Mr. J. Horrigan, Master Mechanic of the Elgin, Joliet & Eastern, has been appointed Superintendent of Motive Power of that road and the Chicago, Lake Shore & Eastern.

Mr. H. M. Wissimir, formerly with the Baldwin Locomotive Works, has been appointed Master Mechanic of the Ohio Southern, with headquarters at Springfield, O., to succeed Mr. H. M. Sehart, resigned.

Mr. Lester I. Knapp, general foreman of the Lehigh Valley shops at Buffalo, N. Y., has been appointed Master Mechanic of the Buffalo division, succeeding Mr. J. S. Chambers, resigned.

Mr. Edwin T. James has been appointed Master Mechanic of the Lehigh Valley, with headquarters at Wilkesbarre, Pa., to succeed Mr. H. D. Taylor, resigned.

President Van Horne of the Canadian Pacific has resigned and is succeeded by Mr. T. G. Shaughnessy.

Mr. S. A. Crone has resigned as Assistant Superintendent of Motive Power and Rolling Stock of the New York Central & Hudson River Railroad to take a position with the Gold Car Heating Co.

Mr. Thos. Fildes has resigned as Master Car Builder of the Chicago Division of the Lake Shore & Michigan Southern and has been appointed Assistant Superintendent Motive Power of the Long Island R. R.

BOOKS AND PAMPHLETS.

Light Railways at Home and Abroad. By William Henry Cole, M. Inst. C. E., late Deputy Manager, North-Western Railway, India; 334 pages, with plates and illustrations. London: Charles Griffin & Co. Philadelphia: J. B. Lippincott Co. 1899.

The author of this book is evidently an engineer and he has been also a manager of a railroad. He discusses the history and theory of light railroads and compares the practice of different countries. The book is the most comprehensive and complete that we have seen on the subject and it is valuable to those who are interested in providing feeders for existing roads and to the projectors of cheap extensions. The author does not appear to favor any particular gage of track, but he considers the standard gage of a country as possessing the strong claims for consideration that Americans have demonstrated it to have. Our early railroads were all "light" ones and they became what they are because of natural growth. Why not urge the standard gage at the outset? This battle of the gages

has been fought to a conclusion in this country and the experience should not be lost. Mr. Cole has arranged the subjects logically and has included a discussion of the English railways, rates and necessities of the farmers. The descriptions of foreign practice cover all of the railroad countries and a chapter treats of road transport as an alternative. An entire chapter is given to the gage question, another to construction and working and one to locomotives and rolling stock. Comparisons of the cost figures given with those of this country would have been much easier if English money terms were used in place of Indian. The book contains a large amount of information which is useful and suggestive in regard to constructing inexpensive spurs. Railroad managers will find it interesting to compare the problems, in this respect, of foreign countries with our own. The author very sensibly suggests the advantage of building light railroads with second-hand material discarded from heavy roads. He discusses tracks, yards, switches, sidings, stations and operation. The book is well printed and well illustrated.

American Railway Association Proceedings. From its Organization as "The General Time Convention" in 1886 to October, 1893 inclusive. Edited by W. F. Allen, Secretary, 24 Park Place, New York. Price \$5.

This volume contains a valuable record of the proceedings of the American Railway Association and its predecessors. The record begins with the organization of the General Time Convention in 1886 and is brought down to 1893. The volume is large, containing 755 pages, 8 by 11 inches in size, which is uniform with the regularly issued semi-annual numbers. To show the value of this book it is only necessary to say that it contains the discussions and proceedings which led up to the adoption of the present time system, the standard code of train rules and important deliberations on such subjects as couplers, signals, car mileage and car service. The entire volume, including the appendices, is carefully indexed and this exhibits the care taken in the work by Mr. W. F. Allen, Secretary, of the Association. Mr. Allen's thoroughness and conscientiousness is seen throughout the reports which contain valuable tables and data which he compiled. To many the annual presidential addresses by Col. Haines will be a specially interesting feature. The book is inscribed with the title Volume I., which would indicate that the proceedings subsequent to 1893 are to appear in the same form, the advantages of which require no comment. Members doubtless have these reports, but their value is greatly increased by combining and indexing them because of the possibility of securing the history of any subject conveniently. The letter press and binding are excellent, the work throughout being very creditable.

International Universal Exposition, Paris, 1900. General information for citizens of the United States of America who desire to become exhibitors. Regulations, classifications. Compiled under the direction of the Commissioner-General for the United States. Chicago, Ill. January, 1899.

This pamphlet contains the law establishing the commission for the United States, the decrees of the President of the French Republic, the staff of the exposition, a description of the buildings and grounds, classification of exhibits, railroad agreements, arrangements for transporting and handling exhibits and decrees with regard to awards. The American Commission has offices in the Equitable Building, New York, the Auditorium Building, Chicago, and at No. 20 Avenue Rapp, Paris.

A. B. C. Telegraph Code Specially Adapted for the Use of Financiers, Merchants, Shipowners, Brokers, Agents, etc. By W. Clauson-Thue. Fourth edition. New York. American Code Publishing Co., 83 Nassau St. 1899. Price, \$5.

This code is the most widely used and this edition, which is the fourth, is the best that has appeared. The price is reduced from \$7.50 to \$5 without a corresponding change in the make-up of the book. The code itself is too well known to require comment. The only criticism we offer is that it should have the title on the back of the book, where it may be seen when standing on a shelf.

Professional Papers of the Corps of Royal Engineers, edited by Captain R. F. Edwards, R. E. Vol. XXIV. 1898.

History of the Pennsylvania Railroad Company, with Plan of Organization, Portraits of Officials, and Biographical Sketches. By William Bender Wilson. Two volumes (6½ by 9 inches). Illustrated. Bound in cloth. Philadelphia, 1899: Henry T. Coates & Co. Price per set, \$5.00.

Those who have wished for a written history of the Pennsyl-

vanla Railroad from its inception to its present development will be glad to know of the appearance of this book. It is the result of the labor of years and, aside from the fact that it is a record of the Pennsylvania Railroad, it has a value in relation to the wonderful development of this country, to which the railroad systems have contributed. The book gives a history of the construction of the lines east of Pittsburgh and Erie, leased, owned and operated by the Pennsylvania Railroad Company, together with the plan of organization, biographies of the executive and chief operating officials, an account of the jubilee celebration and memorials of the men who during their lifetime contributed to the present condition of the road. The type is large, the binding good, and the illustrations include many of structures that have long since been replaced in the growth of the property. It is a record that many will be glad to have, and not the least of its features are the biographies of the men who have made the road.

Liquid Air and the Liquefaction of Gases. By T. O'Connor Sloane, Ph. D. Published by Norman W. Henley & Co., New York. Price \$2.50.

It is too early to print an entirely satisfactory treatise on liquid air and the liquefaction of gases, but the author of this work has brought together the history of the subject and has made a very interesting collection which will be sought for by many who desire to know what has been accomplished with descriptions of the methods and appliances used. There are 17 chapters, seven of which give biographies of the experimenters in this field. The first chapter is on physics and contains the remarkable statement that the theory of conservation of energy has long since been discarded. The second chapter is on heat and its measurement, the third on heat and gases, heat of vaporization and the spheroidal state. In this chapter the relation between temperature and pressure and the subject of "critical temperature" are discussed. Recent apparatus and experiments are described in the remaining chapters. The book is interesting and well worth reading. It is not too deep for readers who have not the advantage of technical educations.

Air Brake Diseases; Their Symptoms and Cure. By Paul Synnestvedt. A revision of "Diseases of the Air Brake System," by the same author. Chicago, The W. F. Hall Printing Co. 1899.

The success of Mr. Synnestvedt's first work on this subject, published four years ago, and the improvement of air brake apparatus since that time have made a new edition necessary. In addition to revising the earlier work, the author has included new matter and has rewritten portions, such as the chapter on pumps. A new chapter on the diseases of the air signal is included and the entire work is much improved. The author's well-known reputation as an authority on all air brake subjects and the increasing importance of useful maintenance render the work a valuable one and it should have an extended distribution.

The Shearer-Peters Paint Co., Cincinnati, have issued a ten-page pamphlet containing recently written testimonials in regard to the service of their paints in several kinds of extremely severe exposure. One who attempts to preserve the literature of protective coatings of iron and steel finds a large accumulation in a short time, but good opinions formed after severe tests are not common. After making an experimental application of paint furnished by this company the Pittsburgh, Bessemer & Lake Erie Railroad recently ordered a large quantity with the statement that it was wanted specially for painting the front ends of locomotives. We have already noted the satisfactory experience of Mr. W. H. Lewis, Superintendent of Motive Power of the Norfolk & Western Railway, with this paint for locomotive smokeboxes. This pamphlet also gives records of fire-proof paint and paint used under water and subjected to the action of steam and of powerful acids. Pyro paint is a coal tar product secured by a process which is stated to eliminate the destructive elements of the tar and at the same time renders it non-combustible. For this reason the manufacturers give a guarantee in strong terms for Pyro paint as a coating for locomotive smokeboxes. They also give a strong guarantee for the paint used on roofs.

The Clayton Air Compressors. Catalogue No. 10. The Clayton Air Compressor Works. 70 pages (6 by 9 inches; illustrated. This catalogue presents the complete line of air compressing

machinery and accessories as manufactured by these builders. It contains illustrations, descriptions and lists of sizes of standard patterns, and illustrates descriptions of the Clayton type of compressors. It also includes tables and other data concerning compressed air transmission and losses by compressors operating at various altitudes. Air receivers, vacuum pumps, carbonic acid gas and high pressure compressors are also presented.

Westinghouse Electric & Manufacturing Co., Catalogues No. 222, direct-connected railway generators; No. 223, lightning arresters; No. 225, alternating current fan motors; No. 226, direct current fan motors; No. 228, polyphase motors. These catalogues are in pamphlet form and contain clear, concise descriptions with good engravings and plain directions for ordering. No. 228, which is devoted to Tesla polyphase induction motors, is specially worthy of attention because of the interest in and advantages of this type of motor. It has no brushes and no circuit connection with the armature which renders it specially well adapted for use in shops and exposed situations. This form is used at the Concord shops of the Boston & Maine Railroad, illustrated in our issue of April, 1898, page 114. We cannot imagine any power producing unit simpler than this form of motor. The reasons for its success are made clear by the description in this catalogue. This motor is particularly well adapted for railroad shops where expert attendance is not always available.

Car Heating Apparatus Catalogue for 1899 by the Safety Car Heating & Lighting Co., 160 Broadway, New York. This is a 54-page, standard size (8¼ by 10¼), illustrated pamphlet with large folded plates and sectional and detail drawings of the car heating equipment manufactured by this company. The standard and direct steam heating systems are fully described, including the car and locomotive equipment and the detail parts. The illustrations are from drawings and indicate an unusual amount of care to secure clearness, especially those illustrating the small details such as valves, jackets, couplers and fittings. A valuable feature is an appendix giving a record of forms of apparatus that have been superseded by improved devices. The catalogue gives evidence of a desire to enable the system to be thoroughly understood. It is successful in this and is also convenient. The parts are numbered for ordering and an index of the contents is provided. The paper and printing are excellent. Every officer who has to do with car heating should procure a copy.

Russell Snow-Plows and Flangers.—The 1899 catalogue of the Russell Snow-Plow Company contains illustrated descriptions of this well-known line of plows and flangers together with several half-tone reproductions of photographs showing the disastrous consequences of neglecting the provision of efficient snow removers. During the past year the company has had more orders than could be filled. The catalogue closes with the following paragraph: "We guarantee the Russell snow-plows to be better than any other plows or machines to clear railroad tracks of ordinary, hard or deep snow and to be much the best devices, if not the only ones, with which serious delays or blockades may be prevented during severe snow storms." The records made by these plows and printed in the pamphlet should be read by those who were responsible for the serious delays by snow blockades during the past winter.

Catalogue No. 6. Chicago Pneumatic Tool Co. This is a 6 by 9 inch illustrated pamphlet of 100 pages and is the most complete issued by this company. The engravings are half-tones from retouched photographs, showing the various pneumatic tools and appliances at work and the variety of uses to which they are put. The pamphlet also includes engravings showing the parts of each of the principal tools with numbers, for convenience in ordering.

Premium Plan of Paying for Labor. The "American Machinist" has found sufficient interest in the subject of the premium plan for paying for labor to necessitate reprinting in pamphlet form a recent article by Mr. F. A. Halsey, giving results of experience and a discussion of the principles involved. The "American Machinist" will send copies of the pamphlet free to

Dixon's No. 635 graphite, for lubricating gas engine cylinders, is strongly endorsed by quotations from letters written by engineers and others which are printed in a leaflet recently received from the Dixon people. The graphite is considered indispensable for gas engine cylinder lubrication, and its use, mixed with oil, is recommended for general lubrication.

EQUIPMENT AND MANUFACTURING NOTES.

A strong endorsement of the new semaphore glasses perfected and manufactured by Mr. John C. Baird, 83 Franklin St., Boston, has been received in the form of a letter from Mr. J. P. Coleman, Assistant Engineer of the Union Switch & Signal Co., to Mr. Baird, from which the following is quoted: "Your solid Nels signal red glass is an innovation in this field, as I have always understood that the veneering process of applying the red to one side of a clear glass was the only way of producing glasses serviceable for red signal lights. My attention was some time ago called to a lens thus colored from which the veneering had cracked off and a white light displayed when a red one was intended. Your method should prevent such conditions, which are vital, when white constitutes a safety light. I believe it is to you the credit of having first introduced a yellow glass of serviceable quality for distant signals is due, and its introduction on the N. Y., N. H. & H. R.R., and here at the Boston Southern Station, has given ample opportunity for demonstrating its practicability. The excellence of your Nels signal green is beyond any question. I am especially interested in the development, inaugurated on the New Haven System by Mr. C. Peter Clark, of using red for danger, green for safety and yellow for caution, and I see no reason for questioning the color produced by your yellow disk at 2,000 ft. under the worst atmospheric conditions, and this to my mind is an ample distance through which any distant signal light need be visible at any time. I hope for the early arrival of the day when white lights will have been abolished entirely from the field of light signals."

A substitute for red and white lead and similar preparations for steam, gas and other pipe joints, was brought prominently before the recent convention because of its use in connection with the steam and air piping of the exhibits. This material is known as "Gumbo Cement," and is manufactured by the Gumbo Cement Co., 161 Lake St., Chicago, Ills. It is a mineral product in the form of a powder and is prepared for use by mixing with boiled linseed oil. Strong claims are made for its effectiveness in making tight and durable joints, which, however, may be easily taken apart at any time because of the freedom from corrosion. It is said to preserve rubber and other gaskets. A few sharp taps from a hammer are said to loosen the joint so that it may be unscrewed. It appears to be adaptable to many joints about locomotive boilers, boiler fittings, piping, front ends and tenders. For air pipe joints the cement is mixed with varnish or with boiled linseed oil and Japan dryer. When used for stopping leaks it is mixed in the same manner as for air pipes and it will harden in from 30 to 45 minutes. This cement has been used for nearly four years. The manufacturers report that it is now regularly ordered by the Standard Oil Co., the Pullman Palace Car Co. and over 100 railroads.

A significant fact concerning the demand for the W. Dewees Wood Company's patent planished jacket iron for locomotive use is that it has been practically coincident with the growth of the transportation interests of this country. Years ago, before the late Mr. Wood invented his planished iron, the American locomotive builders used Russia iron jackets, recognizing their economy and general desirability above painted jackets used by European roads. But the advent of Wood's jacket iron gave America a jacket superior to Russia iron at a much lower cost; and, of course, its adoption was only logical. Some American railroad systems use painted iron jackets, but the majority of these use jackets of Wood's planished iron for all passenger engines. It would appear that no two roads using painted jackets agree on the question of their economy. The European painted locomotive jacket is heavier and much more expensively finished than is any similar American one; but yet, as between European painted jackets and those made of Wood's planished iron there is no question as to the handsomer appearance, lower first cost and general economy of the American product.

During an inspection of brasses at the works of the Ajax Metal Company, recently, out of 3,200 brasses only one-half of one per cent. showed discoloration from heating. This is a remarkable record.

The Norwood side bearing for freight and passenger cars which was exhibited at the Old Point Comfort convention, attracted a great deal of attention on account of the model whereby the relative frictional resistance of it and an ordinary side bearing were comparable. The Norwood bearing uses four 1½-inch very hard tool steel balls with a pair of castings so arranged as to form seats for the balls. The upper seat is in two parts, the lower of which is slotted to a length sufficient for the maximum travel, and cut out to such a width as to allow the balls to project through the slot and bear against the lower plate on the truck bolster, when the side bearings are closed together. This slot is sufficiently narrow, however, to lift the balls from the lower seat when the bearings are separated. The slot is made widest at the center in order to insure the return of the balls to the center of the travel by gravity when the side bearings are separated. The suspension of the balls, free side movement and keeping them central by gravity are claims that are strongly urged by the Baltimore Ball Bearing Co., the manufacturers. It is claimed that the balls will not wear flat. Better side bearings are needed, as has frequently been stated in these columns, and this one should have a good trial because it promises well.

The Bullock Electric Manufacturing Co., of Cincinnati, O., are experiencing the practical results of prosperous times coupled with a record for high grade electrical machinery. Their new factory, with treble the capacity of their former works, and with new tools being added almost daily, is severely taxed to supply promptly the machines called for by its sales department. This difficulty, however, will soon be obviated by increased facilities. Numerous special machine tools, which have been delayed by the crowded condition of the maker's factories, are soon to arrive, and with these in operation, it will be possible to deliver more promptly. The type "N" Bullock slow speed motor, so admirably adapted to the driving of machine tools and other machinery by direct connection, is receiving much deserved attention from consulting and contracting engineers both at home and abroad.

Diamond Steel Emery.—A pamphlet has been received from the Pittsburgh Crushed Steel Co., of Pittsburgh, Pa., presenting the advantages of crushed steel abrasive as compared with emery and other abrasives. This crushed steel abrasive is exceedingly hard and sharp. It cuts but does not break in use, which renders it durable and very effective as will be seen by the testimony of mechanical officers of railroads who are using it. Samples of six sizes, sufficient for a convincing test, will be furnished upon application. A representative of the American Engineer has witnessed experiments with this abrasive upon which we endorse it heartily.

The Pneumatic Supply & Equipment Co., of New York, recently organized to install complete compressed air plants, have received an order for three duplex Corliss air compressors for the Tubular Despatch Co., the owners and operators of the pneumatic mail transmission tubes in New York City. These three compressors are to be located in the sub-basement of the Metropolitan Life Insurance Building, New York. The capacity of each compressor is in excess of 1,300 cubic feet of free air per minute, and the entire cost of the installation is stated to be over \$12,000.

Rubber Mats, Matting and Treads as manufactured expressly for railroads are described in a small folder by the Boston Belting Co. These mats are low in price, attractive in appearance and durable. The style used by the Chicago & North Western Ry. for cars have the initials of the road in the center panel. The car step treads are made to conform to the shape of the steps and initials are placed in panels of these also when desired. The pamphlet illustrates the corrugated matting used by the Illinois Central for the floors of car vestibules, the initials of the road being in white letters. The durability of the matting is said to be equal to its attractiveness.

Keasbey & Mattison's magnesia lagging was specified for use on the boilers and cylinders of the freight locomotives built by the Schenectady Locomotive Works for the Midland Railway (England) and illustrated elsewhere in this issue.

The Chicago Pneumatic Tool Co. has arranged with the National Pneumatic Tool Company to sell the entire output of their factory, in connection with the pneumatic tools now handled by the Chicago company. This gives the Chicago Pneumatic Tool Company control of the sales of the Phoenix rotary drills, the new Haeseler piston drills and the appliances manufactured by the National Pneumatic Tool Company, as well as the Boyer riveters, hammers and piston air drills.

The International Correspondence Schools of Scranton, Pa., evidently intend to maintain their rights in their copyrighted instruction papers and pamphlets, clear evidence of this being seen in a circular just received from The Colliery Engineer Co., containing an account of recent litigation against the United Correspondence Schools and others for infringement. This circular contains the decision of Judge Lacombe and constitutes a caution to those who may be tempted to make improper use of the copyrighted papers of the International Correspondence Schools.

The Chicago Pneumatic Tool Co. has sent two expert operators of pneumatic riveters from the works of the Chicago Ship Building Co. to England and Scotland for the purpose of exhibiting the possibilities of pneumatic riveting in the ship yards there. The results which will be shown will probably be astonishing when compared with the methods in use in those yards and the export business, which is already large, is expected to greatly increase in consequence.

Edward Robinson, proprietor of the Wells Light, 44 and 46 Washington St., New York, recently returned from England after a very pleasant trip, taken partly in the interest of the Wells Light business and partly for pleasure. During his absence abroad 1,500 of the now famous Wells lights were sold to the Russian Government for use upon railroads in that country.

The International Correspondence Schools of Scranton, Pa., have secured the conviction of James F. Miller, representative of the "American Correspondence Schools," of Boston, in the Supreme Court of Erie County, New York, for slander in statements made by him reflecting on the integrity of the International Correspondence Schools. The jury awarded \$350 damages and placed the costs on the defendant.

Mr. E. P. Bigelow has been appointed General Eastern Agent of the American Steel Foundry Co., with offices in the Havemeyer Building, New York.

The Siberian Railway has an appropriation of \$3,497,500 for expenditure during the current year for improvements in the form of new rails and facilities for increasing the speed of trains. According to the London "Times," the increase of the traffic on the eastern and still more on the western section of the Siberian Railway has surpassed all expectation. Its construction was originally planned on economical lines, but the pessimist forecast of little or no movement for some years to come are being falsified by the facts. Consequently, the light rails, which are only 54 pounds, instead of 72 pounds, to the yard, will have to be changed. Everything was calculated for not more than three pairs of trains per 24 hours, whereas there are already eight pairs, besides the bi-weekly express from Moscow to Krasnovodsk. The last year's traffic returns of the western Siberian section show 350,000 passengers, nearly 490,000 tons of goods, and 400,000 peasant emigrants. Last winter, although 600 new trucks were added and 1,600 old ones borrowed, there was an accumulation of 7,000 truck loads of goods for which no means of transport could be found. Of the 490,000 tons carried over the railway in 1898, more than 320,000 tons consisted of cereals. In the course of the next five years, it is expected that the carriage of wheat here will reach over 800,000 tons per annum. In the Altai mining district alone at the present moment there is a surplus of 355,000 tons of wheat, while in Central Russia whole populations are suffering from actual famine.

MASTER CAR BUILDERS' ASSOCIATION. THIRTY-THIRD ANNUAL CONVENTION.

ABSTRACTS OF REPORTS.

Trains Parting.

Committee—G. N. Dow, John Hodge, D. Hawksworth, J. M. Holt.

Our circular of inquiry was sent out to 189 roads, representing 1,252,219 cars. Replies were received from 8 roads, representing 130,074 cars, or 4.23 per cent. of the roads and 10.33 per cent. of the cars represented in the Master Car Builders' Association. The roads whom we have to thank for furnishing the committee with information for a report are as follows: Chicago & West Michigan, Northern Pacific, Burlington & Missouri River, Michigan Central, Lake Shore & Michigan Southern, New York, Ontario & Western, Chicago, Milwaukee & St. Paul, and Atchison, Topeka & Santa Fe.

Seven roads reported 2,606 cases of trains parting between December 1, 1898, and April 1, 1899. [These reports are then analyzed in detail by the committee.—Ed.]

Cause for trains parting that were equipped with M. C. B. couplers in detail for 1,506 cases, as follows:

1. Defective locks	263 cases, or 17.46 per cent.
2. Worn knuckles	197 cases, or 13.08 per cent.
3. Defective uncoupler attachment	84 cases, or 5.53 per cent.
4. Broken coupler body	120 cases, or 7.97 per cent.
5. Defective draft rigging	147 cases, or 9.76 per cent.
6. Broken knuckles	208 cases, or 13.81 per cent.
7. Miscellaneous causes	487 cases, or 32.34 per cent.

In view of the information obtained in the report, your committee would respectfully submit the following recommendations:

Maintaining spindles not less than 2 inches diameter, and keys not less than $\frac{1}{2}$ by 2 inches. Also more care to be used in making pockets, avoiding sharp corners on rear end of pocket.

In the inspection of cars a close inspection to be made of knuckles and locks, with view of reducing unnecessary play in knuckles and locks.

The committee believes that it is necessary to make a systematic inspection of couplers in service, with a view of limiting the variation from the M. C. B. contour line, using a special gauge for the purpose. So far the committee has had but one gauge presented to it for consideration, sketch of which accompanies this report.

Committee would recommend M. C. B. buffer blocks on all cars to relieve the shock to draft rigging in slacking up, thereby reducing to a minimum break-in-twos induced from such causes. (Mr. Hodge excepted.)

Compensation for Car Repairs Done West of the 105th Meridian.

Committee—J. N. Barr, S. P. Bush, J. H. McConnell, L. C. Haynes, T. B. Kirby.

Note.—Mr. McConnell did not sign the report.

Considerable information as to the actual cost of the different materials used in the repairs of cars in interchange has been obtained, which shows, in addition to the cost of the different items, the recommendations of the different roads as to what percentage should be added to the present M. C. B. prices for repairs west of the 105th meridian, also the mileage made by cars on foreign roads and the mileage of foreign cars on each road reporting. The amount collected and paid for mileage and the amount collected and paid for repairs of cars under the Rules of Interchange. The roads reporting are arranged on the statement in four groups. The first group includes lines entirely or largely west of the 105th meridian. The second group includes lines both east and west of the 105th meridian. The third group includes lines which lie between Buffalo and Omaha. The fourth group includes roads entirely or largely east of the meridian of Buffalo.

Your committee also attaches statement (No. 2) copied from the Interstate Commerce Commission's Ninth Annual Report for the year ending June 30, 1896, showing the freight earnings per ton per mile for lines over 250 miles long wholly or nearly west of the 105th meridian, and for fifty representative roads east of the 105th meridian. It is the opinion of your committee that this information should be taken into consideration in discussing this question.

In taking up the question as to differentials in compensation for car repairs made under the Rules of Interchange west of the 105th meridian, the most important consideration, next to the individual prices for the different items, is, as shown on the statement, the amount paid annually to foreign lines in interchange and the amount collected annually from foreign lines for repairs to cars. In case the two amounts should be equal, there would be no occasion for any further consideration of the question. For example: If the roads west of the 105th meridian should pay foreign roads \$20,000 for the repairs of their cars, and should collect from other roads \$20,000 for repairs of foreign cars, the difference in the cost of doing the work as compared with M. C. B. prices would not be any advantage or disadvantage to the parties concerned. The statement, however, shows that the western lines collect more for repairs than they pay, and on account of this difference there is a loss to

these lines as compared with the other lines in the United States.

It is the loss on this portion of the amount of repairs for which undoubtedly the western lines ask relief. In order to secure such relief, they ask that they be allowed to charge other roads a certain percentage above the established M. C. B. prices. In other words, they ask for a differential in cost of repairs made west of the 105th meridian. In taking a broad view of the subject, the third group of roads should ask for a corresponding differential in their favor, as against the fourth group of roads as shown in statement No. 1. The same applies to the various other groups shown on the statement, and in order to be strictly equitable in arranging prices, there should be a differential between a number of different roads in the same group. For example, the C. & O. R. R. pays 15 cents per hour for repairs to cars, the Fitchburg R. R. pays 19 cents. The C. & O. R. R., in making repairs, has the advantage of 4 cents per hour on labor as compared with the Fitchburg R. R. The same remarks apply to many of the items of material used in repairs. The statement certainly shows that this discrepancy is greater when we compare the roads in group No. 1 with any of the other roads shown in the statement, but this is a difference in degree. Your committee does not see its way clear to make a special recommendation in the case of the western roads without doing an injustice to many other sections of the country. The scarcity of labor and cost of transportation, together with other considerations, increases the cost of doing the repairs on cars on the western lines, but this variation exists to a greater or less degree as shown above. In view of the above mentioned scarcity of labor and cost of material, as well as other circumstances, the freight earnings per ton per

of the opinion that in the consideration of any change in cost, necessarily the mileage compensation should also be taken into consideration. If in our section of the country 6/10 of a cent per mile is sufficient remuneration for the use of a freight car and the present M. C. B. prices for repairs are based on such a figure, then any radical change in the cost of repairs, in justice necessitates a consideration of the cost of the mileage, as one seems to your committee to be inseparable from the other.

In conclusion, in view of the complexity of the differential question, of the variation in remuneration and cost of repairs, which varies in all sections of the country, your committee feels that it cannot recommend any change in the established policy of uniform prices for all parts of the country.

M. C. B. Couplers.

Committee—W. W. Atterbury, W. P. Appleyard, W. S. Morris.

The subject as assigned to your committee was as follows: "M. C. B. Couplers: To define contour lines more fully when new and when worn, and propose specifications for couplers."

The topic may be divided into three parts: 1, to define the contour lines more fully when new; 2, to define the contour lines more fully when worn; 3, to propose specifications for couplers.

1. To define the contour lines more fully when new. This part of the subject can again be divided into four parts, none of which are covered by present M. C. B. standards: (A) To fix the length of the guard arm; (B) The vertical dimension of

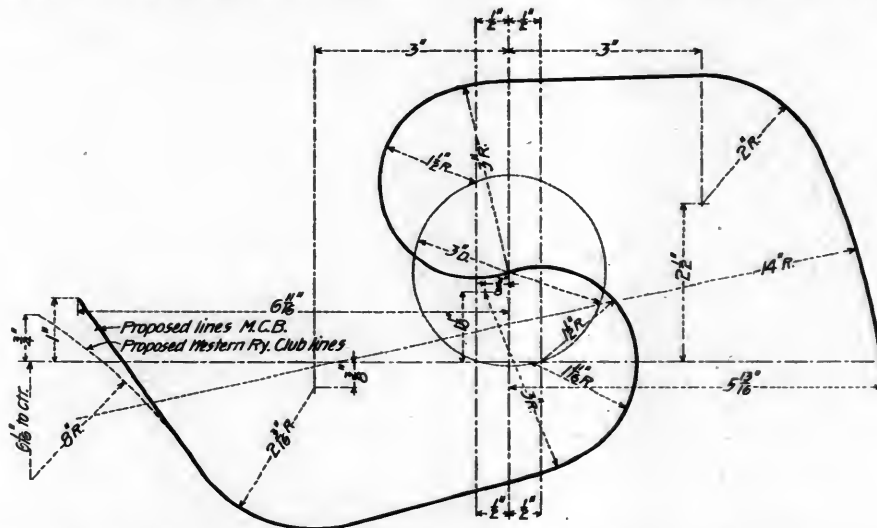


Fig. 1.—Proposed Modification of Contour Lines of M. C. B. Couplers.

mile on the ten roads west of the 105th meridian is shown to be a little more than 1 cent greater or more than 100 per cent above the average freight earnings per ton per mile for the entire United States. On the fifty roads east of the 105th meridian shown on the statement it is only 1/100 of a cent, or 1 2/10 per cent, above the average for the United States. By referring to the figures showing the amounts collected and paid for repairs to cars in interchange, it will be apparent to any one that this item is an excessively small amount as compared with the total cost of freight repairs on any road, and at the same time the advantage of 100 per cent. increase over the general average of the freight earnings of the United States runs into immense figures. Under these circumstances, it would be scarcely right for the roads west of the 105th meridian to ask the eastern lines to share a portion of the extremely small burden of cost of repairs on interchange cars.

As a question of more specific character, and bearing more intimately on the subject under discussion, it may be mentioned that the eastern roads furnish their cars to run over western lines and furnish them in some cases at a mileage cost to the western roads of less than it actually costs them to maintain their own cars. It is very possible, in view of this state of affairs, that roads west of the 105th meridian have three cars per mile of track, while roads east of the 105th meridian average over seven cars per mile. Of course, the mileage of foreign cars over western lines could be reduced by their increasing their equipment, but according to the figures this could only be done at a much greater loss than what is occasioned by paying mileage on foreign cars and doing the repairs at a lower figure than the actual cost. This same argument also applies to all roads in various sections of the country and is undoubtedly the reason why they are willing to submit to discrepancies in the cost of repairs, which might otherwise be a serious source of contention. Even if the above circumstances did not exist, it is a question as to whether it would be proper for the western roads to ask the other lines to share a portion of the burden which is forced upon them by reason of their location, and your committee is inclined to the opinion that the M. C. B. Association cannot take into consideration and endeavor to alleviate those unfortunate circumstances. Your committee is

the knuckle; (C) The vertical dimension of the end of the guard arm, and, (D) To refer the axes upon which the contour lines are constructed to the axis of the shank of the coupler.

(A) In regard to the length of the guard arm, it is recommended that the contour lines be extended about one inch beyond the point where they at present terminate, and that the M. C. B. Standard Limit Gauges for new couplers have the guard arm screw moved from its present position to a new one at the end of the proposed new contour lines. (B) It is recommended that the vertical dimension of knuckles be fixed at nine inches as a minimum. (C) It is recommended that the vertical dimension of the end of the guard arm be fixed at seven and one-half inches as a minimum. (D) It is recommended that the twist gauge for new couplers, shown in Fig. 11, be used so as to insure that the heads are neither twisted nor displaced sidewise with relation to the shank.

In addition to these matters relating strictly to the contour line, there are others that require attention: (E) It is recommended that the horizontal plane containing the axis of the shank of the coupler bisect the vertical dimensions of the knuckle and end of guard arm. (F) It is recommended that the gauge for new knuckles be used on all knuckles purchased separately for renewals. (G) It is recommended that the vertical height of the stop shoulder or horn of coupler be not less than three and one-half inches, and that the horn be arranged to touch the striking plate before the back of the head of the coupler strikes the ends of the draft timbers.

2. To define the contour lines more fully when worn. This takes in the subject of gauges for worn couplers, and it is recommended that the gauge shown in Fig. 41 be used. These gauges are cheaply made of sheet metal stampings, and it is earnestly recommended that they be immediately put into use at all interchange points, and that the same care be given to the examination of couplers as is given to any other portion of the car. We have no doubt the use of this gauge will put a stop to a large percentage of the instances of trains parting on the road without couplers unlocking.

3. To propose specifications for couplers. This part of the subject has received very careful consideration. It has been difficult to reconcile the diametrically opposite opinions which

have been expressed by various railroad men and manufacturers.

It is believed, however, that rigid specifications and tests will do much to weed out the poorer makes of couplers at present being furnished, and it is recommended that in the future all couplers be purchased subject to the provisions of the following standard specifications and tests.

SPECIFICATIONS.

After September 1, 1899, all M. C. B. automatic car couplers purchased by or used in the construction of cars for the above-named company must meet the requirements of the following specifications. [The important items are included.—Editor.]

Couplers must conform to M. C. B. contour lines, dimensions and gauges. They must couple and uncouple with each other (with either or both knuckles open) and with the master or sample coupler. They should unlock easily, and should lock with freedom when the knuckle is pushed in by hand. They must have complete locking fixtures.

They must have steel pivot pins $1\frac{1}{2}$ or $1\frac{3}{4}$ inches in diameter, and of a uniform length of $13\frac{1}{2}$ inches from the under side of head to the center of pin hole for $\frac{3}{8}$ -inch cotter. Pivot pins, after being heated and having the head struck up, must be carefully and properly annealed.

Knuckles must conform closely to dimensions and fit neatly in coupler head, so that the contour will conform strictly to M. C. B. gauges. The coupling pin hole must not be less than 1 9/16 inch nor more than 1 1/2 inch in diameter, and must be parallel with the face of knuckle and at right angles with the axis of the knuckle. The weight of the coupler complete to be not less than—lbs., and of bar without any of the attachments not less than—lbs. The minimum weight of each knuckle to be—lbs. As many drawbars and knuckles as possible must be cast from each heat of steel or melt of iron used. All parts to be well annealed throughout. Couplers and parts will be submitted to the following five distinct tests:

1. Striking test on closed knuckles of complete coupler. Coupler to be held in machine so that the axis of the coupler is in the center line of drop, and the axis of the coupling pin hole passes through the center lines of the legs of the machine and the shank of the coupler rests solidly on the anvil. Blows to strike directly on knuckle.

Three blows of 1,640 pounds weight falling 5 feet.

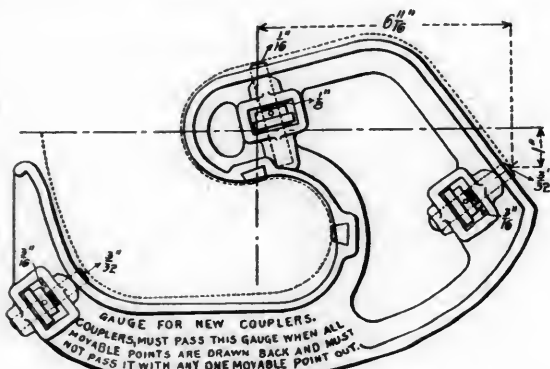


Fig. 3.—New Cage for New Couplers.

Three blows of 1,640 pounds weight falling 10 feet.

A coupler will be considered as having failed to stand this test when it is broken before it has received three blows at 5 feet and three blows at 10 feet, or when any cracks appear more than 1 inch long or open more than 1/16 inch, or when the center line of the shank is distorted more than 1 inch from its original position, or when the knuckle is found to have closed more than 3/4 inch from its original position when pulled out against the lock after having received the three blows at 5 feet.

2. Jerk test of complete couplers. Two couplers to be supported in the machine by the yoke forgings and draft springs provided. Blows to strike directly on the equalizer bar connecting the two couplers and resting on their closed knuckles.

Three blows of 1,640 pounds weight falling 5 feet.

Three blows of 1,640 pounds weight falling 10 feet.

A coupler will be considered as having failed to stand this test when it is broken before it has received three blows at 5 feet and three blows at 10 feet, or when any cracks appear more than 1 inch long or open more than 1/16 inch, or when the knuckle has opened more than 1/2 inch from its original position or so that the equalizer bar will not stay in place when struck.

3. Pulling test for complete couplers. Two couplers to be supported in the pulling machine by yoke forgings, to be locked together as in the running position, with their axles in the same straight line. Couplers to stand a steady pull of 120,000 pounds if fitted with steel knuckle and 85,000 pounds if fitted with wrought-iron knuckle. A coupler will be considered as having failed to stand this test when it is broken before it has been pulled the prescribed number of pounds, or when any cracks appear more than 1 inch long or open more than 1/16 inch, or when the knuckle is found to have opened more than 3/4 inch from its original position when pulled out against the lock, or when the couplers slip apart in the pulling machine.

In case of the failure of any part of the complete coupler under tests 1, 2 and 3, those parts which may not have failed may be submitted for a future test, providing such parts shall not be condemned by the individual tests hereinafter specified.

4. Guard arm test of drawbar. Drawbar to be held vertically in machine so that the edge of guard arm is in the line connecting the centers of the legs of the machine, and so that the shank rests solidly on the anvil. Blows to strike directly on the edge of the guard arm.

For Malleable Iron Couplers.

Three blows of 1,640 pounds weight falling 3 feet.

1,640 pounds weight falling 5 feet.

For Steel Couplers.

Three blows of 1,640 pounds weight falling 3 feet.

Four blows of 1,640 pounds weight falling 5 feet.

A drawbar will be considered as having failed to stand this test when it is broken before it has received the prescribed number of blows, or when any cracks appear more than 1 inch long or open more than 1/16 inch, or when the center line of shank is distorted more than 1 inch from its original position, or when the head is distorted sufficiently to allow the hammer to hit on the face of the bar, or the lugs of the bar to strike against the hammer.

5. Separate knuckle test.

Knuckle to be laid horizontally on one of its lugs, upon a solid anvil, and given the following blows upon the top of one lug:

Knuckles pivoted 2 inches or less from center of pivot pin hole to face of knuckle to stand—

Three blows of 1,640 pounds weight falling 3 feet.

One blow of 1,640 pounds weight falling 4 feet.

Knuckle pivoted 3 inches or less from center of pivot pin hole to face of knuckle to stand—

Three blows of 1,640 pounds weight falling 3 feet.

Two blows of 1,640 pounds weight falling 4 feet.

Knuckles pivoted over 3 inches from center of pivot pin hole to face of knuckle to stand—

Three blows of 1,640 pounds weight falling 3 feet.

Three blows of 1,640 pounds weight falling 4 feet.

A knuckle will be considered as having failed to stand this test when it is broken before receiving the proper number of blows, or when any cracks appear more than 1 inch long or open more than 1/16 inch.

At the end of all the above tests, except No. 5, couplers will be tried for disablement. Knuckles must open and locking de-

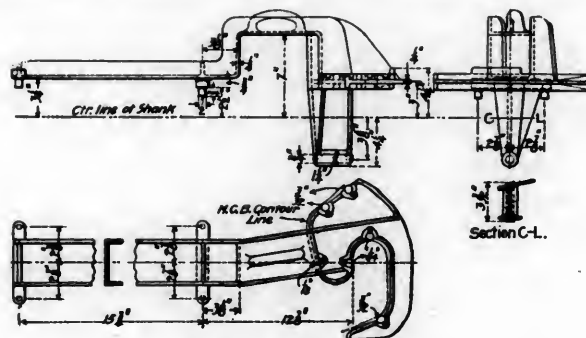


Fig. 11.—Twist Gage.

vices be operative after the coupler has received the specified test.

Before testing, couplers must have a row of center-punch marks put upon the center line of top of shank, so distortion can be detected.

General Considerations.

In addition to these matters pertaining strictly to its subject, the attention of the committee has been called to the fact that in some cases couplers with shanks of dimensions differing from the standards of the Association are being made and introduced in service. As this change will affect the standards of the Association and work possible hardship to other railroads in the way of interchange of cars, we call the attention of the Association to this, with a view that the subject of increased dimensions of the shank be referred to a committee for further investigation, and report what changes, if any, should in their judgment be made in present standards of the Association. It is also suggested that the back corners of the yoke in the pocket attachment be changed from $\frac{1}{4}$ inch radius to $\frac{5}{8}$ inch radius. It is further suggested that the play of the shank of the coupler in the carry iron be not less than $\frac{1}{2}$ inch on each side.

Another matter which has claimed considerable attention is a standing committee on couplers. It is recommended that such a committee be appointed, whose duty it shall be to test couplers submitted to them. A standing committee on coupler tests has been suggested from time to time, somewhat after the manner of the Standing Committee on Triple Valve Tests, and Brake Shoe Tests. There ought to be some way of certifying to the proper design and quality of so important an appliance as a coupler, and this committee would prove a very valuable addition to the others.

In conclusion, the situation in regard to the multiplicity of couplers and parts is brought to the serious attention of the Association. There should be some way of reducing the present uselessly extravagant manner in which repair parts for the

so that the average of the total blows the coupler received can be ascertained by an inspection of this figure. Three blows at 3 feet were given first, and then the 5-foot blows. The total fall of the drop in feet is shown by the length of the line.

The construction of a standard drop testing machine has long been urged and the accompanying drawings are submitted as embodying a satisfactory design. In the first place, the machine must be reproducible. A machine built on rock foundation should give just the same results as one built on soft soil. To this end it has seemed indispensable that the anvil should be spring supported. As strong and rigid a foundation as can be built must be put down, and the capstone covered with a cast-steel bed plate, having recesses cored in it to receive the steel housings for the legs of the machine. The 15-foot blows will be abandoned, as all the testing necessary can be done with the 10-foot blows, and the 15-foot blows have been found to be too destructive to the auxiliary apparatus in jerk tests, yoke forgings and equalizer bars breaking when submitted to these severe shocks. Besides that, it seems to be difficult to get couplers to stand even 10-foot blows, so that 15-foot blows may be left out of the question entirely. The anvil is made heavy enough to absorb in itself all blows and is supported on springs which are wound on definite sizes of mandrels, and from steel to fulfill definite specifications. The uprights to support the brackets carrying the yoke attachment for jerk test are bolted down to the anvil, and leave plenty of room for the latter to rise and fall easily. The machine is accessible in the highest degree, and couplers can be easily and quickly put in and taken out in all tests. By the use of steel blocking and wedges, all couplers are held firmly in drop tests, and all are put on the same basis. It is believed that this machine can be built anywhere, and couplers tested on it are sure of receiving the same treatment as others tested in a different place.

Air Brake Appliances.

Committee—A. L. Humphrey, A. M. Parent, H. C. McCarty.

Replies to the circular received would indicate that the prevailing opinion among a large majority of the members was that the location of cylinder and triple valves should be so arranged as to make them easy of access for the repair men; however, from the plans submitted and the design generally adopted throughout the country, it would indicate that their desire was not to make this question the paramount consideration, thereby sacrificing the efficiency of the brake, but to take both into consideration. Your committee has, therefore, endeavored to locate a line of consistency between the two extreme ideas, one side appearing to favor the idea that the cylinders should be located entirely with a view of making it more convenient and less hazardous for the repair men; while the others think the location of the cylinders should be determined entirely by the design of truck and body leverage used, so as to get as straight a pull on the rods as possible, regardless of the repairs necessary to be made from time to time. We would therefore respectfully recommend:

The adoption for clear bottom cars, for the location of the

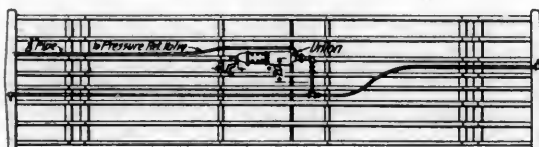


Fig. 3.—Proposed Standard Piping for Clear Bottom Cars.

air cylinder and triple valve, between the needle beams, with a clearance of not less than 12 inches between the needle beams and the end of the cylinder head, and located about 20 inches from center of car to center of cylinder, longitudinally, the exact position of which will, to a certain degree, have to be determined by the local conditions. This position renders it convenient for cleaning and repairing, and at the same time makes it possible to arrange a very convenient system of leverage.

Cars not having clear bottoms, as hoppers and center-dump gondolas, should have the cylinders located on the side of the car, as near the inside of the side sills as the design of the car will permit. This will avoid the danger incident to the repairs of cylinders and triple valves located at the end of the hoppers.

The committee would recommend for standard design of piping for clear-bottom cars design as shown in Fig. 3, in which we have endeavored to do away, as far as practicable, with all screw joints, substituting pipes with bends of as great a radius as possible. The location of the pipe hangers at the ends of cars when applied to the end sill is considered as contributing largely to the trouble experienced in loose pipes, and it is recommended that the hanger be attached to one of the longitudinal sills.

It is recommended that the location of the main air pipe at the ends of cars be determined by a horizontal measurement (of 13 inches) from the center line of the shank of the drawbar to the center line of pipe, and also a measurement (of 13 inches) from the inside face of the M. C. B. knuckle to the center of the plug of angle cock.

With regard to substitution of bends of long radius in cars

not having clear bottoms, more difficulty will be experienced than with the clear-bottom car.

The committee has been especially impressed with the insecure manner in vogue of fastening the air cylinders, reservoirs, retaining valves, pipes, etc., to the framework, and would therefore recommend that the bolts fastening the cylinders and reservoirs be either double nutted or cottered, so as to prevent same from working loose, and that the air pipes be securely fastened to the framework of the cars with a liberal number of clamps. The application and care of retaining valves has, in the opinion of your committee, been badly neglected.

Your committee desiring an expression regarding the use of what is known as the dummy coupler, asked in its circular whether or not it had been discarded, to which those representing about half the number of cars replied that they had discarded same and believed that its use was a detriment rather than a benefit. This leaves a small majority in favor of the use of the dummy coupler, and it is the opinion of your committee that if a coupler could be devised which would work automatically so that it would not be necessary for an operator to use it, that such a device would be of undoubted advantage.

In the circular of inquiry the committee asked the following question: "As we believe exact conformity to the Westinghouse recommended air brake practice, as shown by their charts, is an unusual thing rather than a common practice, please express your views as to the advisability of adopting the Westinghouse recommended practice, with such modifications as a committee of this Association, working in co-operation with the Westinghouse Company's representatives, might agree upon."

Replies to this question were practically unanimous, and indicated that the representatives replying considered the Westinghouse recommended practice was the proper thing, with such modifications as a committee appointed by this Association in co-operation with representatives of the air brake company might agree upon. Your committee would, therefore, recommend that another committee be appointed to confer with the representatives of the air brake company, with a view of making a further report of their conclusions and what they would recommend.

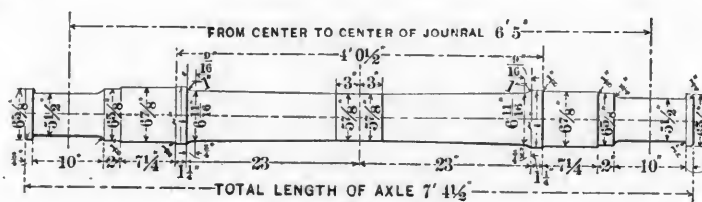
Wheels and Axles: Specifications for Wheels and Axles for 60,000, 80,000 and 100,000 Pound Cars.

Committee—E. D. Nelson, Wm. Garstang, J. J. Hennessey.

A report was made to this Association and read at the Convention of 1897, on "Specifications for Cast-Iron Wheels." This report brought forth some discussion, but its recommendations were not submitted to letter ballot, and therefore not adopted by the Association.

Your committee has gone over the report of 1897, and has concluded that it cannot do better than to present the same report with some minor changes. These changes are as follows:

First.—To include only 33-inch wheels, because this diameter



NOTE

NORMAL WEIGHT OF AXLES 700 LBS.
AXLES MUST NOT EXCEED 800 LBS.

Axle for 100,000-Pound Cars.

has become universal for cars of 60,000, 80,000 and 100,000 pounds capacity.

Second.—For the drop test where the wheel is struck centrally on the hub, it is recommended that the wheel must stand ten blows instead of five of a 140-pound weight falling twelve feet.

Third.—For the drop test where the wheel is struck on the plate, close to the rim, your committee has added wheels of 625 pounds and 650 pounds.

Fourth.—The form for the face of the weight used in the drop tests is specified.

Fifth.—The thermal test is made compulsory with either the drop test on hub or drop test on plate.

Axles.

At the convention of 1898 a voluntary report was made to the Association recommending a design for an axle for cars of 100,000 pounds capacity. [The substance of this report was printed in our issue of September, 1898, page 299.—Editor.] Your committee presents with this report a design for such an axle, it being the same as referred to in the report mentioned.

Concerning specifications for axles, your committee has gone over those contained in the report of a Committee on Axle for Cars of 80,000 Pounds Capacity, made in 1896, and would submit the following revised specifications:

[From the complete specifications we reproduce the following paragraphs.—Editor.]:

Specifications for Steel Axles.

All axles must be made of steel, and the material desired have the following composition:

Carbon	0.40 per cent.
Manganese, not above	0.50 per cent.
Silicon	0.05 per cent.
Phosphorus, not above	0.05 per cent.
Sulphur, not above	0.04 per cent.

All axles will be tested physically by drop test. The testing machine must conform in its essential parts to drawings which will be furnished by the..... R. R. Co. These essential parts are: the points of supports on which the axle rests during tests must be three feet apart from center to center; the tup must weigh 1,640 pounds; the anvil, which is supported on springs, must weigh 17,500 pounds; it must be free to move in a vertical direction; the springs upon which it rests must be twelve in number, of the kind described on drawing; and the radius of supports and of the striking face on the tup in the direction of the axis of the axle must be five (5) inches. When an axle is tested it must be so placed in the machine that the tup will strike it midway between the ends, and it must be turned over after the first and third blows, and when required, after the fifth blow. After the first blow, the deflection of the axle under test will be measured in the manner specified below.

It is desired that the axles, when tested under the drop test as specified above, shall stand the number of blows at the height specified in the following table without rupture and without exceeding as the result of the first blow the deflections given:

Axle.	No. Blows.	Height of Drop.	Deflection.
M. C. B. 4½ by 8 inch journals for 60,000-lb. cars....	5	34 feet.	7 inches.
M. C. B. 5 by 9 inch journals for 80,000-lb. cars....	5	43 feet.	6 inches.
M. C. B. 5½ by 10 inch journals for 100,000-lb. cars....	7	43 feet.	4½ inches.

Axles will be considered as having failed on physical test and will be rejected if they rupture or fracture in any way, or if the deflection resulting from the first blow exceeds the following:

M. C. B. axle, 4½ by 8 inch journals.....	8 inches.
M. C. B. axle, 5 by 9 inch journals.....	7 inches.
M. C. B. axle, 5½ by 10 inch journals.....	5½ inches.

Axles will be considered to have failed on chemical test and will be rejected if the analysis of the borings taken as above described gives figures for the various constituents below, outside the following limits, namely:

Carbon	below 0.35 per cent., or above 0.50 per cent.
Manganese	above 0.60 per cent.
Phosphorus	above 0.07 per cent.

In order to measure the deflection, prepare a straightedge as long as the axle by reinforcing it on one side, equally at each end, so that when it is laid on the axle the reinforced parts will rest on the collars of the axle, and the balance of the straightedge not touch the axle in any place. Next place the axle in position for test, lay the straightedge on it, and measure the distance from the straightedge to the axle at the middle point of the latter. Then, after the first blow, place the straightedge on the now bent axle in the same manner as before, and measure the distance from it to that side of the axle next to the straightedge at the point farthest away from the latter. The difference of the two measurements is the deflection.

As the Master Car Builders' Association now has adopted, as standard, three axles, it is recommended for the purpose of identifying these more readily that they be designated by numbers, as follows:

M. C. B. No. 1.....	Axle with journals 3½ by 7 inches.
M. C. B. No. 2.....	Axle with journals 4½ by 8 inches.
M. C. B. No. 3.....	Axle with journals 5 by 9 inches.
M. C. B. No. 4.....	Axle with journals 5½ by 10 inches.

Uniformity of Section for Car Sills.

Committee—R. P. C. Sanderson, J. S. Lentz, N. Frey.

The two principal purposes which your committee aimed to accomplish were:

First, to recommend such sizes of sills as would be suitable for general use in the design and construction of all new flat-bottomed cars having timber sills, trusting that, if adopted, the loyalty of the members would induce them to prefer these sizes to any others in all new work hereafter.

Second, to choose such sizes that would be most generally suitable for the repairs of the great majority of the cars now in service.

In preparing the circular of inquiry your committee did not think it advisable to consider any cars below 50,000 pounds capacity, less than 32 feet in length, or of special construction. It is gratifying to note the very general interest taken in the subject by the members, as is shown by the large number of responses received, and your committee feels that the field has been well covered. The railroads that have replied to your committee's circular represent a total of 853,014 cars of 50,000 pounds capacity and over, out of a total of 1,252,219 cars.

The information has been condensed and tabulated in the tables which follow, one for box, stock, flat and gondola cars over 32 feet and under 40 feet in length, and of 50,000 pounds capacity or over; the other table covers only cars of 40 feet or over in length, mostly furniture cars or long gondolas.

The thickness and depth of sills given in the tables are finished sizes, and the figures in the table represent the aggregate number of cars reported as having sills of the given sizes.

For instance, by referring to the table for cars over 32 feet and under 40 feet, it will be seen that for sills having a thickness of 5 inches and a depth of 8 inches there are 105,259 cars in service. As the result of the study of these tables your committee feels justified in recommending the following finished sizes for sections of longitudinal car sills:

For cars such as box, stock, flat, long gondolas, refrigerators, etc., 32 ft. and over in length, but under 40 ft.:

4 by 8 inches.	4 by 9 inches.	4 by 10 inches.	4½ by 12 inches.
4½ by 8 inches.	4½ by 9 inches.	4½ by 10 inches.	5 by 12 inches.
5 by 8 inches.	5 by 9 inches.	5 by 10 inches.	5 by 14 inches.

For cars 40 feet long and over, such as furniture and special long gondolas:

4½ by 8 inches.	4½ by 9 inches.	6 by 9 inches.	6 by 12 inches.
5 by 8 inches.	5 by 9 inches.	6 by 10 inches.	6 by 14 inches.
	5 by 10 inches.		

It is believed that the above recommendations afford a sufficient range of sizes to cover all requirements of design; they are good merchantable sizes, and if adopted and used as suggested, we may expect that car repairs will be greatly expedited, as there will be less delay in getting special sizes of lumber, and we will be able to get our requisitions for regular sizes filled more promptly, as the lumbermen can saw in advance of orders with a reasonable certainty of selling their stock.

To further expedite the general introduction of standard sizes for car sills to facilitate car repairs, and reduce stocks of lumber, your committee further recommends that the following paragraph be introduced into the Master Car Builders' Rules of Interchange, to follow Section 3 of Rule 4:

"When renewing long sills in foreign cars requiring odd sizes of lumber, the next larger suitable M. C. B. standard size of sill may be used and considered as proper repairs."

Height of Couplers.

Committee—S. Higgins, J. H. McConnell, C. M. Mendenhall.

The Committee on Height of Couplers, appointed at a meeting of the Executive Committee held in Saratoga last June, has decided not to confer with the American Railway Association and the Interstate Commerce Commission, to get the limits of height of couplers changed to 31 inches minimum, and 35 inches maximum. The investigation made by the committee has satisfied the members of the committee that any increase in the present limits is not advisable at this time.

With knuckles divided in the center by the slot for coupling link, any increase in the limits for height of couplers will result, in many cases, of only one knuckle lug of each coupler being in contact. Any increase in the limits of height of couplers will tend toward a greater number of trains parting, due to one coupler passing over the other. The committee's decision is based on these two facts.

For some time to come there will be a number of link-and-pin couplers in service, and for this reason it is not advisable to make any recommendations toward closing the slot in the knuckle.

The committee thinks that after January 1, 1900, will be time enough for the Master Car Builders' Association to take up the matter with the view to closing the slot in the knuckle, and at that time any increase in the limits for height of couplers should be considered.

Supervision of Standards and Recommended Practice of the Association.

Committee—A. M. Waitt, G. L. Potter, Wm. Apps.

The committee summarizes its recommendations, and would suggest that the following recommendations be submitted to the Association for adoption by letter ballot:

1. That drawing for standard journal boxes, 3½ by 7 inches, show size of bolt-hole 1 1/16 inch instead of 1 inch, to provide for the 1-inch bolt ordinarily used.

2. That Sheet 15, showing journal box in details, for journals 5 by 9 inches, give the general dimensions only for journal bearing, eliminating the general construction of bearing, with lead lining.

3. That the word "coupler" be substituted for "drawbars" in the title and description of the standard height of drawbars.

4. To eliminate guarantee for cast-iron wheels from the list of recommended practice.

5. Substitute the word "couplers" for "drawbars" in the title and text in connection with the recommended practice "Adjusting height of drawbars."

6. Eliminate the drawing and description of the Fletcher journal box lid for 80,000-pound capacity cars from the recommended practices.

The committee suggests that the following subjects be referred to committee to investigate and report at our next convention:

1. Design for wheel circumference measure.
2. Revision of specifications for car wheels.
3. Design for the journal bearing and wedge gauges for 80,000 and 100,000-pound capacity journals.
4. Revision of rules for loading poles, logs and bark on cars.
5. Revision of recommended practice on springs for freight cars, including the consideration of designs for springs for 100,000-pound capacity cars.

[The remaining reports will be printed in abstract next month — Editor.]

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

THIRTY-SECOND ANNUAL CONVENTION.

ABSTRACTS OF REPORTS.

A Research Laboratory Under the Control of the Association.

Committee—G. R. Henderson, W. F. M. Goss, John Player.

1. The Need.—Each succeeding step in the development of a science broadens the outlook. When the facts which bind one condition to another have been fully ascertained, they immediately become stepping stones to new facts, suggesting new conditions, and giving rise to new questionings. Each achievement is a demand for new effort. The process is one of perfecting and has no end. Moreover, the problems arising in this process become more and more difficult as the work proceeds. Not only, therefore, is each achievement a demand for increased activity, but for more perfect methods as well.

The preceding general statements, applicable to the development of any science or art, are especially true of those branches of engineering which are represented by this Association. The past has had its problems; they have been met with masterful energy and many of them have been solved. Facts thus discovered give direction to present practice and constitute the promise of better things to come.

The most significant results which thus far have been presented to this Association are those which have been derived from carefully conducted experiments and study, a process which, for the purpose of this report, will hereafter be referred to as research. These, while they have benefited all roads alike, have been obtained as the result of personal sacrifice on the part of comparatively few members, and at the expense of a few roads.

The establishment of a research laboratory by this Association would be proof of its readiness to adapt itself to the demands of more exacting conditions, and would show in a fitting manner its sense of fairness in requiring contributions from all who receive benefit.

2. A Measure of the Problem.—At the present time there are in the United States, in round numbers, 36,000 locomotives, 33,000 passenger equipment cars, and 1,230,000 freight cars. These are probably worth nearly \$900,000,000. In keeping this rolling stock in repair, there is spent in the neighborhood of \$60,000,000 per annum, not including lubrication and such maintenance. It is thus seen that the value of the equipment and the annual charges for repairing it call for a great outlay of money, and yet there are thousands of points and questions in regard to the design of railroad cars and locomotives which should be cleared up, and upon which valuable (having a cash value) information could be obtained by the proper investigation, conducted in a thorough and reliable manner. One-tenth of one per cent. of the amount paid out yearly for keeping up the condition of the equipment would provide a handsome sum for the purpose of conducting such investigations as have been outlined above. The combustion of one-half billion tons of coal each year is no small undertaking, but the payment for the same is a still greater one. Even one per cent. (a value so small in a comparative test that it is disregarded) of the quantity would be five million tons! And there are hosts of inventors who claim that their productions will save many per cents. These suggestions are merely intended to emphasize the desirability of scientific examination into their merits. There are, of course, many directions along which the spirit of improvement may manifest itself; the present purpose is to urge the adoption of more extensive and equitable methods of developing such scientific facts as are needed to stimulate the deliberations of this Association, which, officially, is charged with the responsibility of maintaining the equipment of 200,000 miles of American railway, and to guide the practice of its members.

3. The Plan.—The committee makes no plea for the details of any plan of organization, but to give definiteness to its argument presents, in the form of an appendix, an outline prepared by one of its members, of the more important features of a plan which appears to be fundamental and safe. Reference to the appendix will show that a large initial investment is not thought necessary, the use of existing laboratories being proposed rather than the immediate establishment of a new plant. Such a plan appears to your committee not only wise, but it is one to which the Association, by its past practice, is already committed. By selecting one laboratory for one line of investigation and another for a second line, the co-operation of men and materials best suited to the needs of the Association would be secured.

4. The Cost.—The cost of organizing and maintaining such a movement, even on the limited scale proposed, would be considerable. Within limits, the results are likely to prove beneficial in proportion to the money which is put into the work. Great returns are not ordinarily expected from small investments. To insure a degree of success which will comport with the dignity of the society, the proposed organization should be assured of existence for at least three years, and money for maintenance during this period should be in sight. The minimum amount which your committee deems necessary for a period of three years is \$40,000, of which \$12,000 should be avail-

able during the first year, and \$14,000 during each of the two succeeding years. If more could be provided, the returns would be still greater. During the period of assured existence the research laboratory may be relied upon to justify its existence to an extent which will thereafter be the means of supplying whatever may be necessary for its proper conduct. If it were to fail in this it would be time to stop expenditure.

5. Routine Work.—It is likely that the existence of an organization for research would lead to work of a routine character, such as examination of water, chemical and physical tests of materials, etc., for individual roads, especially for smaller lines which do not now maintain laboratories nor have engineers of tests. If undertaken at all, the cost of such work should be paid for by parties receiving benefit, and could, therefore, be self-supporting. Routine work, however, should not be undertaken at all along lines in which private laboratories are prepared to give satisfactory service at reasonable cost, for such work is distinctly less significant than that of research. The one may serve to keep practice up to known standards, but the other is the basis which serves to advance practice. A research laboratory, therefore, should not be drawn away from its high calling by the allurements of minor interests.

6. In conclusion, that the matter herein presented may receive proper consideration, your committee would recommend the passage of the following resolution, to wit:

Resolved, That in the opinion of this Association there is need of more concerted action in the development of such practical and scientific facts as are needed to direct practice in the design and maintenance of railway equipment; and,

Resolved, That the Executive Committee be and hereby is directed to carefully consider the plan for a research laboratory under the direction of the Association; and is authorized to formulate a plan of organization; to ascertain by what methods the necessary money can be assured; and, so far as may be practicable and expedient, to proceed with the actual work of organization; also,

Resolved, That in case the Master Mechanics' Association should become merged into, or consolidated with, the Car Builders' Association before action is taken under these resolutions, the persons who at the close of the present convention represent this body in an executive capacity, be and hereby are authorized and directed by this body to present the whole question covered by these resolutions to such Directors or Executive Committee as may hereafter represent the interests which are now intrusted to the care of this Association or of the two associations named; and be it further

Resolved, That it is the desire of this body to have presented a report of progress at the next annual convention of this Association, or at the next convention of such Association as may one year from date represent the interests of this Association.

Best Methods of Preventing Trouble in Boilers from Water Impurities.

Committee—A. E. Manchester, J. H. Manning, S. P. Bush, H. Bartlett, R. M. Galbraith.

[This report is voluminous and exhaustive. It covers a large field and owing to the impossibility of presenting it in abstract the conclusions of the committee only are reproduced.—Editor.]

Recommendations of the Committee.

The first effort in preventing trouble in boilers from water impurities should be in searching out sources of supply furnishing the best obtainable feed waters.

1. In building a water station where, by a larger first outlay, water of a better quality (that is, costing less for purification) may be obtained, the question should be carefully considered before accepting the poorer water in order to save first cost of plant. The treatment of water is expensive, and the cost will pay the interest on a large investment. For example, in a station furnishing 100,000 gallons of water in twenty-four hours, which costs $4\frac{1}{2}$ cents per 1,000 gallons for purification, were it possible to substitute a supply costing but $2\frac{1}{4}$ cents per 1,000 gallons for treatment, an outlay of \$16,425 would be warranted in order to bring about the change. The annual cost for purifying the $4\frac{1}{2}$ -cent water would be \$1,642.50; for the $2\frac{1}{4}$ -cent, \$821.25; the difference in the cost for the two treatments being \$821.25, which equals 5 per cent. on an investment of \$16,425.

2. Where necessity compels the use of troublesome water there are few cases where by treatment, either mechanically or chemically, fairly good waters for boilers may not be obtained, the important consideration being the method employed. There are in the market numerous so-called water purifiers, purges, oils and boiler-cleaners, many of them absolutely worthless, others dangerous. It should be a rule never to allow the use of any compound for this purpose until its effects and dangers are fully understood.

3. The cost of purifying waters will always be cheap when compared with the use of waters which cause trouble in the boiler. The best methods to be employed can only be determined when the conditions are fully understood. The cost for water purification depends on the character of the water and the methods and reagents employed. Lime and soda ash are the cheapest of the effective and harmless reagents for this purpose, and direct treatment in the tender is the least costly method.

Waters carrying twenty-five grains of incrusting matter per gallon, five of which are sulphates, may be successfully treated with soda ash at a cost of about 40 cents per 1,000 miles of engine mileage, or about 6.12 mills per 1,000 gallons of water.

With engines equipped with blow-off cocks of sufficient num-

ber and correctly located, and with four per cent. of water taken blown out, in keeping boiler free from sludge, the engine may be safely and satisfactorily run from 2,000 to 3,000 miles between washouts.

Assuming the cost for untreated water to be 10 cents per 1,000 gallons, the 4 per cent. wasted in blowing out would represent a value of 4 mills per 1,000 gallons, or a total for treatment and waste of 10.12 mills. In this calculation no account is taken of the heat losses in the water blown out, and if the blowing out be done at the end of the trip, when the engine goes into the roundhouse for a layover, it should not be. But if on the road, a further cost equal to the value of the heat in the water wasted should be added to the other expenses for water purification.

In waters of the character and treated by the methods just referred to, the results that may be expected from engines in freight service is that 100,000 to 200,000 miles may be made between changes of flues, and that the life of fire boxes will be from eight to fifteen years.

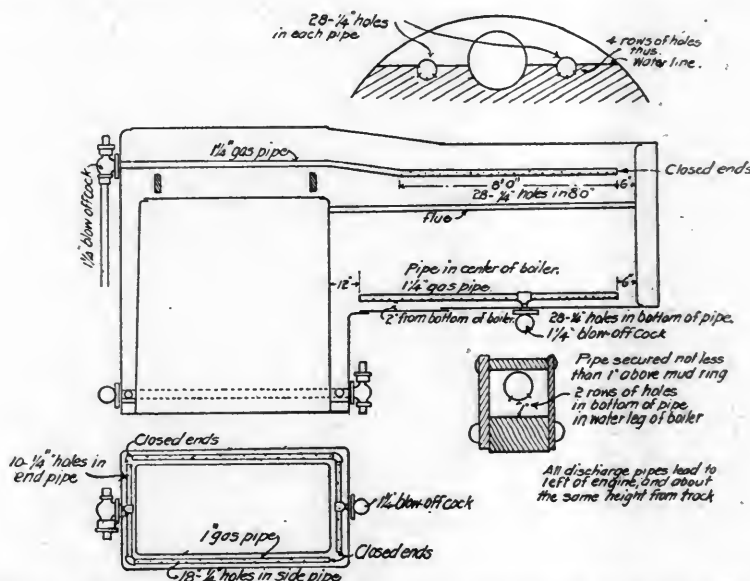
Water with forty grains of incrusting matter, seven or eight of which are sulphates, may be treated in the same manner with fairly good results, but with an additional cost for reagents and blowing out in proportion to the increase in incrusting matter and sulphate.

Treatment of water in the station tank, as represented by the several cases already alluded to, costs for reagents from

Power, where the size of the system will warrant, and boiler feed waters are troublesome, two specialists; one a boiler washing inspector, who has charge of the boiler washing. In the performance of his duties, he should as often as possible visit the different roundhouses and shops to see that they are equipped with and using the tools intended for this purpose; that the boiler washers understand how, and are doing good boiler washing; where soda ash put in the tender is the reagent and method employed for purification, to see that the correct amount is properly put in, observe the manner in which the blowing off is done, and to stay at each point until a personal inspection has been made of all boilers cared for by them.

The other specialist should be an assistant to the chemist, and should have a knowledge of the chemistry of water, and a good understanding of geology; the water supply of the system, so far as relates to quality, to be directed by him. Among his duties to be the searching for, and locating, the best sources of water, looking after the condition of water in existing stations, and where any falling off in quality develops, to determine cause. The analysis records and reports in relation to water purification and supply, and its performance in the boilers, to be under his charge. He should spend a part of his time on the road personally inspecting pumping and purifying plants and methods, and should keep in close touch with the boiler washing inspector, roundhouses and shops.

A man of this character, with a correct understanding and



Arrangement of Surface and Blow-Off Cocks on Locomotives of N. Y. C. & St. L. R. R.

2 1/4 to 4 1/2 cents per 1,000 gallons, and we estimate the loss of water in cleaning the settling tank, and in blowing out to keep the concentration of alkali to a safe limit, to be as great as by the direct method. The first cost for the water station is greater and will be further increased by the introduction of automatic devices for delivering the reagents. On the other hand, the special advantages are that the treatment may be varied to suit each particular condition of water; also that the water freed from sludge will carry a greater concentration of alkali without trouble from foaming.

The cost for treatment of water by mechanical purifiers or cleaners is for the water and heat lost in blowing out. The blow-off cock is the active agent for purification in all mechanical cleaners; the part performed by the remainder of the devices is to assist in bringing mud within its reach.

An engine fitted with blow-off cocks, as shown in Fig. 5, which is the standard on the N. Y. C. & St. L. R'y, is, we believe, fully equipped with a good purifier.

When waters contain little or no sulphates, or where alkali is troublesome or earthy matter is in suspension, they may be successfully handled by mechanical devices.

We do not consider it safe practice, where sulphates are to be dealt with, to depend upon mechanical devices, except they be reinforced by chemical reagents for neutralizing the incrusting matter.

The cost for clarification of water by filtering or settling is for first cost of plant, the interest and maintenance of same. By the unaided method, the only other expense should be for attendant and water used in cleaning.

With the mechanical filter, the water used for this purpose should not exceed 5 per cent. of the amount pumped, and the time consumed in cleaning should be about fifteen to twenty minutes every five to ten hours. Where coagulants are used, there will be an additional cost for chemicals of 1 to 2 cents per 1,000 gallons of water clarified.

The cost of water purification by evaporation, as already explained, represents the most effective practice of the day. The practice given will be varied in proportion as the cost of labor and fuel be greater or less than the figures used in the case cited.

4. There should be on the staff of the Superintendent of Motive

well directed efforts, would make himself useful in the department, and be the means of materially lessening trouble in boilers from water impurities.

Relative Merits of Cast-Iron and Steel-Tired Wheels for Locomotive and Passenger Car Equipment.

Committee—J. N. Barr, H. S. Hayward, A. M. Waitt.

To the committee circular ten replies were received, two of which gave mileage information. These two reports were furnished by the Lake Shore & Michigan Southern and Chicago, Milwaukee & St. Paul Railways.

The Norfolk & Western Railway reports that cast-iron wheels are used exclusively except in the case of engine trucks. Here steel-tired wheels are used as a matter of safety. The price of a 600-pound cast-iron wheel is \$4.85 as made by this company. This price does not include cost of superintendence or repairs of buildings.

The Chicago, Burlington & Quincy Railway, through Mr. G. W. Rhodes, says: "It has always been our practice to advocate cast-iron wheels made to Master Car Builders' specifications and tests when they do not exceed 33 inches in diameter, as being the cheapest wheel to use, and as safe a wheel as any steel-tired wheel." One exception is made to this: For engine trucks steel-tired wheels are used, as they are considered less liable to have broken flanges. For wheels larger than 30 inches diameter, it is thought steel-tired wheels should be used, but have a number of 37-inch cast-iron wheels in service with no indications of breakage. In the last few months this road had two steel-tired wheels broken, one of which derailed a car. Tire was fastened by a Gibson retaining ring. A similar case has occurred with a cast-iron wheel recently.

The Lake Shore & Michigan Southern Railway, through Mr. Stevens, in addition to the information given on the statements, reports as follows: Average number of turnings for steel-tired wheels is two, and cost \$1.25; steel-tired wheels are safer than cast-iron wheels; otherwise the relative merits are about the same.

The Lake Shore & Michigan Southern Railway, through the General Master Car Builder, report in addition to data given

in statements: Cost of turning steel-tired wheels, \$1.62 per pair; average number of turnings, 4.

The Chicago, Milwaukee & St. Paul Railway report as follows: Cost of turning steel-tired wheels, \$1.85 per pair; average number of turnings, 4. Steel-tired wheels are safer than cast-iron wheels for engine trucks, on account of tendency of these wheels to breakage of flanges. For all other service, their experience has been that cast-iron wheels are safer than steel-tired wheels. The actual number of breakages of such a character as would derail a car is greater for steel-tired wheels than for cast-iron, although about ten times as many cast-iron wheels as steel-tired wheels are in service. Steel-tired wheels are more expensive in both passenger car and locomotive service. The cost per 1,000 miles for steel-tired wheels is more than three times as great as for cast-iron wheels.

Your committee regrets that more information based on actual records was not furnished, as conclusions on this subject should be based on facts and not on unsubstantiated opinions. It should be remembered that the item of wheel service is the most expensive single item with which we have to contend. The mileage obtained from the best cast-iron wheels is fully three times as great as the poorest. The factor of safety in favor of the best cast-iron wheels as compared with the poorest bears at least an equal proportion. The same relation as to breakage exists as to steel-tired wheels. While the mileage relations of the various steel-tired wheels approaches much nearer to uniformity, it is not believed that this would be the case if the manufacture of steel-tired wheels were exposed to the same unbridled competition as is the case with cast-iron wheels. Again, the safety of trains from disaster, and even the life of human beings, is so dependent upon the quality of the wheels used that it would seem that railroads would not ignore the necessity of keeping a close watch and a full record of cases of breakages, with a view of eliminating from service wheels of doubtful quality. If it has been demonstrated that steel-tired wheels are safer than cast-iron wheels, railroads cannot afford to ignore this fact, and are without excuse for accidents arising from breakages, at least under passenger cars and locomotives, if the same are caused by breakages of cast-iron wheels, no matter what the difference in cost may be. If, however, there is no difference in the matter of safety, then the cost should decide the question. In the case of wheels, first cost is very far from deciding what is the most economical. Relative durability must always be taken into consideration. This can be done most definitely by keeping an individual record of wheels used, and removed, and the actual mileage of the cars under which the wheels made their service. This method is cumbersome and many roads hesitate in going to the expense of maintaining such a record. The same results, however, can be approximated much more simply and with little labor by the following method: Make record, for example, of all tenders running with 33-inch cast-iron wheels; also of all wheels removed from these tenders during the year; obtain the mileage of these tenders for the same period and multiply by eight to obtain the total wheel mileage; divide this sum by the number of wheels removed, and the result will approximate closely with the actual wheel mileage obtained. While this method omits many details of importance, it gives actual results as a whole, and is much better than no information whatever.

Turning now to the statements presented with this report. [Not reproduced.—Editor.] There is considerable discrepancy in these reports; the L. S. & M. S. Railway report shows very much in favor of steel-tired wheels; the C. M. & St. P. Railway report shows in favor of the cast-iron wheels.

With the information as presented, your committee is unable to draw any definite conclusion, and would say that further information is required.

As to the comparative cost there is a decided discrepancy in the cost per 1,000 miles in passenger car service, partly due to difference in average mileage and partly to difference in relative value of new wheels and scrap. For locomotives the two reports agree much more closely, and if the discrepancies due to difference between cost of new and scrap wheels were removed the cost of service both for cast-iron and steel-tired wheels would be very close indeed, showing in both cases much in favor of cast-iron wheels.

In conclusion, your committee would say:

First—It is not able to decide from the facts presented whether steel-tired wheels are safer than cast-iron wheels, except in case of engine trucks.

Second—For engine trucks it would recommend steel-tired wheels from considerations of safety.

Third—Cast-iron wheel service is cheaper than that obtained from steel-tired wheels.

Fourth—It would recommend that at least the method detailed above be used for determining wheel mileage.

Fifth—That a careful record of breakages be inaugurated and maintained.

Advantages of the Ton-Mile Basis for Motive Power Statistics.

Committee—H. J. Small, C. H. Quereau, W. H. Marshall.

The following argument on the advantages of the ton-mile basis, made by Mr. Quereau, of this committee, clearly illustrates the desirability of using the ton-mile unit:

There are so many varying conditions, as the quality of coal, scale of wages, types of engines, water, grades, average speeds and the business to be done, that we believe it is unwise to attempt to compare the motive-power statistics of even different divisions of the same system, much less the different systems, except in the most general way. This conclusion is based on

the assumption that the statistics will be compared with a view to bettering the records. We are fully persuaded that it is not only more just, but a better policy, and will secure much better results to compare the records of each division, or system, with those made by the same division, or system, during the same period of previous years.

So long as we rely on a comparison of records made by other divisions or systems, just so long will innumerable excuses be made concerning poor coal, bad water, light or heavy engines, grades, time, and a host of other unfavorable conditions which, whether reasonable or unreasonable, will be used by both officials and employees as good excuses for poor records and failure to improve. If the standard of comparison for each division is the previous record made by that division, the excuses which might be valid when comparison is made with some other division have little or no weight, because the conditions on each division are practically the same one year and another; or if there are noticeable changes, a proper allowance can be much more easily made, as they are well known to the men and officers on that division. For these reasons we believe it unwise to attempt to secure a uniform basis for motive power statistics with a view of making the records of all railroads comparable. We believe, however, that these reasons do not hold good in trying to secure the best basis for motive-power statistics.

It seems to us evident that the basis for engine-service statistics should be the work performed by our locomotives. This work includes the elements of time, distance and weight moved, and a perfect basis for motive-power statistics should include all three of these; under service conditions, however, it is practically impossible to include all three elements, except at a prohibitive expense.

If our statistics are kept under the heads of passenger, freight and switching, and the various runs classified under these heads, the variation due to the influence of time or speed will be very greatly reduced, as with this subdivision of the statistics, passenger records will be naturally compared with other passenger records, and freight with freight, and switching with switching. We believe that if this is done we can afford to neglect the element of time in the basis for our statistics, as such a classification of statistics will reduce to a comparatively small amount the influence of this element.

The loaded-car-mile basis, which is sometimes used, roughly approximates accuracy as far as distance and the weight moved are concerned, and, we believe, is much more accurate than the mile basis, but is far from ideal because of a great difference in the weights and capacities of cars; gives the same value to a load of straw hats and one of pig lead, and arbitrarily fixes the ratio between the weight of empties and loads.

We believe that these objections do not apply to the ton-mile as a basis for motive-power statistics. It is true that the ton-mileage, as obtained under the usual conditions, is not absolutely accurate; that it does not take into account the difference in the power required to haul a ton of grain in empty and loaded cars; that it is difficult, if not impossible, to obtain accurate ton-mileage records of local and stock trains. In short, the ton-mileage records as they are obtained under service conditions are far from perfect, but we believe this basis to be considerably more accurate than the mileage basis, and what is much more important, tends to encourage more economical methods of operating, while the reverse is true with statistics based on the engine-mile.

It has been objected that the ton-mile basis does not take into account the comparative resistance due to grades and speed, to the difference in the power required to haul a given weight of empty cars and loaded. We believe these objections apply with equal force to any other basis which may be used.

It has been stated that the ton-mile is a more accurate basis for engine statistics than the engine-mile because it is a more correct measure for the work done. An illustration will make this clear.

	March 1896.	March 1897.	Increase per cent.
Average miles per engine	2,282	2,289	0.3
Average ton-miles per engine	782,213	972,486	24

On the engine-mile basis the above statistics show that the engines did practically the same work in both 1896 and 1897, while those obtained from the ton-mile figures show an average increase of 24 per cent. There can be no doubt that the ton-mileage is a much more accurate approximation of the work done than the figures giving the average mileage.

Railroad men quite generally rely on the number of miles made to the ton of coal in determining their economy in the use of fuel. This basis is of comparatively little value, and may easily and naturally lead to wrong conclusions, because the fuel used is not compared with the work done.

The matter was aptly summed up by a master mechanic, who said: "When we were operating under the engine-mile system I was glad to see light engines going over my division, because they made my showing better; but now, under the ton-mile system, I dislike very much to see anything of the kind, because it hurts my record."

It would seem that the same line of reasoning which has been applied in comparing the merits of the engine-mile and ton-mile in the case of fuel, should have equal force when considering the proper basis with which to determine the cost of locomotive repairs, and lead to the same conclusion: If an engine goes over the road light, it is credited with as many miles as though it handled a maximum load, but there can be little chance for argument that in the former case the wear on the engine and the chances of a breakdown are a minimum, while when worked to its capacity they are the greatest.

It seems self-evident that the cost of engine repairs per

mile will be least when the engines do the least work, and it can be readily shown that the cost per ton-mile will be least when the engines are worked to their full economical capacity. Therefore, the ton-mile basis, when used in determining the cost of repairs as well as fuel, places a premium on heavy trains, thereby fostering economical operating methods.

At first sight it would appear that there is no good reason for determining the cost of wages on the ton-mile basis, but we believe further consideration will show the contrary. As the cost of wages is now shown, so much per mile, there is no inducement to reduce the cost of this item per ton-mile of freight, because the item of wages, on the mile basis, will be the same on a division which may average five cars per train as on one where the average is five times this. On the other hand, if the wages are compared on the ton-mile basis, it is evident there is a strong inducement to reduce the cost of wages per ton by increasing the tonnage hauled.

If the arguments presented are considered sound, it would seem to be wise to use ton-mile as the unit of comparison for fuel, repairs and wages, or over 95 per cent. of the total cost of locomotive service. With this large percentage on the ton-mile basis, it would seem proper to use it as the basis for the total cost, and all the items. The fact that a railroad has ton-miles to sell, and not engine-miles, seems to me sufficient reason for keeping the cost of locomotive service on the same basis, so that a direct comparison of the selling and cost prices of their commodity can easily be made. It should not be inferred from this that we would advocate doing away with a statement on the engine-mile basis, showing the oil records made by individual engineers, for we believe this important.

Your committee is of the opinion that the present form of locomotive performance sheet, based wholly on the locomotive-mile unit and sent out generally over the country for purposes of general comparison between railroads, is misleading and unsatisfactory; and while it is almost unanimously conceded that the ton-mile unit for freight locomotive statistics is preferable, even this is unsatisfactory, as the expense of a ton hauled one mile over a mountainous road cannot be compared with that of a ton hauled one mile on a level road. Again, a road with few grades, good water and cheap fuel can make a much better showing in operating locomotives than another road with heavy grades, high-priced fuel and bad water.

The theoretical ideal system, perhaps, was that introduced by Mr. F. W. Johnstone, Superintendent Motive Power of the Mexican Central Railway, and in use on that road from 1884 to 1896. His system reduced all work done by locomotives to the unit of 100-gross tons hauled one mile over a straight and level track, the road being reduced to the equivalent of a straight and level track.

Your committee, after a study of the various methods of compiling and presenting locomotive statistics, are of the opinion that greater uniformity of practice is necessary, without which no satisfactory results can be obtained, also that the use of both the ton-mile and the locomotive-mile unit are necessary to properly exhibit all locomotive performance, the former for freight service and the latter for passenger, switch, and work service, and we have endeavored to present in the accompanying form [This is an admirable blank form which, on account of its large size, is not reproduced here.—Editor.] those features which seem to present in the most precise form the information required by all. This form provides for a summary of performances and expense for comparison between divisions of a system, or one system with another, as it seems clear that the requirements of the different roads in making up individual performance of locomotives are of more importance locally than they could be as a matter of comparison with other roads.

The Use of Nickel Steel in Locomotive Construction.

Committee—Tracy Lyon, P. Leeds, A. E. Mitchell.

This material was first brought into practical prominence at the time of the armor plate tests of the Government at Annapolis in 1890. It also came to be used by the Government for deck plates and stay bolts, but it was not until about 1896 that its use in this country began for locomotive construction; first in piston rods, crank pins, axles, and later in fire-box plates, side rods and stay bolts. Up to this time, however, nickel steel has only been used in locomotive construction in an experimental way.

Nickel steel is stated to be not a difficult alloy to manufacture, requiring no special furnaces, tools or thermal conditions. The cost of the nickel itself was, until 1875, \$6 to \$7 a pound, so high as to make its use for such a purpose impossible, but the opening in Canada of the most extensive pickel mines yet discovered has reduced the price to from 30 to 40 cents a pound.

Although nickel has been alloyed with steel in almost every proportion, what may now be called commercial nickel steel contains from 2 to 5 per cent. of nickel. Such a material possesses great uniformity, the nickel being uniformly distributed throughout the ingot and not subject to segregation like other ingredients of steel, although some of the earlier experiments seemed to indicate a tendency, with more than 2½ per cent. of nickel present, toward the formation in the heart of the ingot of long needle-shape crystals, which forging, hardening or annealing would not cause to disappear.

The addition of the nickel to steel adds particularly the qualities of toughness, durability and resistance to corrosion. Commercial nickel steel may possess the same elongation as

ordinary steel with a tensile strength 30 per cent. higher and an elastic limit at least 75 per cent. higher. This greater strength, and particularly the higher elastic limit, would appear to make its use for structural material, boilers and machinery, far more advantageous than ordinary steel, especially where a saving in weight is desired and the parts are subjected to alternating stresses.

With increased steam pressures, boiler plates two inches and more in thickness are demanded, bringing with them serious difficulties in handling and construction which it may be possible to obviate by using nickel steel plates 25 or 30 per cent. thinner.

Most of the nickel steel made in this country contains about 3 per cent. of nickel, and it is stated that such material can be worked without difficulty; rolled, forged, pressed in dies without cracking, flanged, punched, welded and machined. There seems to be no doubt, however, but that nickel steel cannot be machined as easily as low carbon steel. It takes the edge off tools very rapidly and the finishing out is apt to sliver. The best of machinery and tools are required to cut a clean thread on stay bolts. One authority says that an alloy containing 1 per cent. of nickel can be easily welded, but that with more nickel the difficulty of this operation increases. With more than 5 per cent. of nickel all of these operations become considerably more difficult. A French authority states that it requires ten times more time to corrode a 5 per cent. nickel steel when dipped in dilute muriatic acid than an ordinary soft steel containing 0.18 carbon. Other experiments, made by leaving planed plates exposed to the action of sea water for a year, showed a loss by corrosion of nickel steel plates of 1.36 per cent.; of mild steel 1.72 per cent.; wrought iron 1.89 per cent. A nickel steel has been offered for use for locomotive tanks on account of its non-corrosive qualities.

The Government specifications for the nickel steel propeller shafts of the U. S. S. Brooklyn required a tensile strength of 85,000 pounds and 50,000 pounds elastic limit. The Navy appears to be using nickel steel very extensively now and provides general specifications covering its present use.

An ultimate resistance of 90,000 pounds can be obtained from 3 per cent. nickel steel with very low carbon, say 0.175, when to obtain this strength in ordinary steel would require at least 0.50 carbon, sufficient to make the material so brittle as to be unreliable. It is claimed that with the right treatment an ultimate resistance of as much as 135,000 pounds can be obtained with steel containing about 3 per cent. of nickel. In general the elastic limit of nickel steel may be depended upon to be above 50 per cent. of the ultimate resistance.

A prominent American manufacturer gives the following specifications as proper for nickel steel parts of locomotives:

Specifications.

	3 per cent. Nickel Steel.	Minimum Tensile Strength.	Maximum Tensile Strength.	Minimum Elongation.	Elastic Limit.	
Crank pins	78,000	84,000	84,000	25% in 2 in.	½ of ultimate	Oil-tempered
Piston rods	78,000	84,000	84,000	25% in 2 in.	"	
Driving axles	74,000	80,000	80,000	30% in 2 in.	"	
Side rods	60,000	68,000	68,000	25% in 2 in.	"	
Firebox plates	60,000	68,000	68,000	20% in 8 in.	"	
Stay bolts	58,000	66,000	66,000	20% in 8 in.	"	

Maximum P. 0.03, S. 0.03, Mn. 0.40, C. 0.25, SL 0.03.

The suitability of nickel steel for tires is particularly mentioned. "The usual test of a tire is that it should stand compressing one-sixth of its diameter without cracking, but one of nickel steel stood compression from a diameter of 39½ to 19 inches without signs of fracture. A crack appearing in the metal does not develop as in carbon steel, and this renders it peculiarly applicable for shafts and axles."

The experience of one of this committee with two piston rods of commercial nickel steel would confirm in a way this latter statement. After having been in service for two years, transverse cracks appeared extending over about one-third of the circumference of the rods and of a maximum depth of ¼ inches. When removed, however, the rods could not be broken with the heaviest sledges, one being finally fractured in a hydraulic press, while the other had to be drilled in two. These rods appeared to be soft, and the wearing surface did not glaze over, although no unusual wear of metallic packing was observable.

A user of nickel steel locomotive crank pins states that there seemed to be quite a variation in the hardness of different pins in the same lot, as evidenced by the behavior of the metal under the tool, and that the reduction in diameter of the softer pins under the pressure of the burnishing roll was particularly noticeable. Another reports the trial of nickel steel bolts in place of iron (where the latter were failing and could not be made larger), but with no benefit.

A few members reported the recent use by them of nickel steel crank pins for locomotives, piston rods and fire boxes. Among the few comments made was one which referred to the rough appearance of nickel steel fire-box sheets, and another that it appeared, from a limited number of nickel steel piston rods in service, that they were more apt to break than those of ordinary steel. (No particulars given.)

It has not been attempted to touch on the use of nickel steel as a material for castings, but much may be looked for in that direction.

[The other reports presented at this convention will be printed next month.—Editor.]

EXHIBITS AT THE CONVENTION.

The following is the list of the companies exhibiting at the recent conventions at Old Point Comfort, Va.

Acme Pipe Clamp Co., St. Louis, Mo.
 Acme Railway Equipment Co., Easton, Pa. Freight, passenger and locomotive couplers. Buffer platform vestibule; steel under framing for car platforms; McKeen carry irons and turn spring draft attachment. Represented by T. L. McKeen, manager.
 Adams & Westlake Co., Chicago.
 American Brake Co., St. Louis, Mo. Locomotive truck brakes and automatic slack adjuster.
 American Brake Shoe Co. Diamond "S" brake shoes.
 American Grain & Car Door Co., Philadelphia, Pa. American grain door, royal flush side door.
 American Machinery Co., Grand Rapids, Mich. Oliver wood trimmers.
 American Manufacturing Co., New York, N. Y. Peerless coupler.
 American Steel Foundry Co., St. Louis, Mo. Models of trucks and couplers.
 Atlantic Brass Co., New York, N. Y. A. B. C. journal bearing.
 Automatic Air & Steam Coupler Co., St. Louis, Mo. Model of the device.
 Baltimore Ball Bearing Co., Baltimore, Md. Anti-friction ball side bearings.
 Bird & Son, F. W., East Walpole, Mass. Torsion proof car roof.
 Bethlehem Iron Co., Bethlehem, Pa. Nickel steel crank pins, piston rods and axles.
 Boston Belting Co., Boston. Samples of air-brake, steam and car heating hose, mats, matting.
 Butler Drawbar Attachment Co., Cleveland, O. Tandem attachment.
 Carborundum Co., Niagara Falls, N. Y. Carborundum wheels and specialties, cloth and paper.
 Chicago Grain Door Co., Chicago. Chicago grain door and Security lock brackets.
 Chicago Pneumatic Tool Co., Chicago, Ill. Pneumatic hammers, riveters, drills, wood borers, flue expanders, staybolt tapers, staybolt biters, staybolt riveters, speed recorders, hoists, heating forge, motors, self-closing hose couplers.
 Chicago Railway Equipment Co., Chicago, Ill. National hollow brake beams, automatic frictionless side bearings.
 Cleveland City Forge & Iron Co., Cleveland, O. Turnbuckle.
 Cloud Steel Truck Co., Chicago, Ill. Cloud pedestal truck, Cloud pressed steel arch bar truck, Bettendorf I-beam body and truck bolster.
 Corning Brake Shoe Co., Corning, N. Y. Brake shoes.
 Crane Co., Chicago, Ill. High steam pressure valves and new air-brake union.
 Crosby Steam Gauge & Valve Co., Boston, Mass. Waterback locomotive gauges, muffler and plain pop valves, chime whistles, spring seat globe and angle valves, Johnstone blow-off cock.
 Dayton Malleable Iron Co., Dayton, O. Dayton draft rigging and the Dayton car door fastener.
 Detroit Lubricator Co., Detroit, Mich. Detroit lubricators with the Tippet attachment, back pressure valves for steam chests.
 Detrick & Harvey Machine Co., Baltimore, Md. Working model of Adam's bolt threading machine.
 Diamond Rubber Co., Akron, O. Full line of rubber goods for railways.
 Fairbanks, Morse & Co., Chicago, Ill. Combined gasoline air compressor and combined gasoline geared water pump, motor velocipede cars, track velocipedes.
 Gardner Safety Window Sash Holder and Combination Lock and Lift, Newburgh, N. Y.
 Goodwin Car Co., New York, N. Y. Five 80,000-lb. capacity steel cars, steel model of car, full size sectional drawings and photographs.
 Gould Car Coupler Co., New York, N. Y.
 Gumbo Cement Co., Chicago. Gumbo cement.
 Greenlee Bros. & Co., Chicago, Ill. Special wood working machinery, tools and square hole borers.
 Jones Car Door Co., Chicago, Ill. Car doors.
 Johns Manufacturing Co., H. W., New York. Full assortment of asbestos goods.
 Joyce Cridland Co., Dayton, O.
 Keasbey & Mattison Co., Ambler, Pa. Magnesia and asbestos, samples of boiler and pipe covering.
 Knitted Mattress Co., Canton Junction, Mass. Padding for car seats.
 Lackawanna Lubricating Co., Scranton, Pa. Lubricators.
 Leach, Henry L., North Cambridge, Mass. Locomotive sander.
 McConway & Torley Co., Pittsburgh. The Buhoup three-stem freight coupler on two 80,000-lb. capacity cars.
 McCord & Co., Chicago and New York. McCord journal box, McCord coil spring damper, Johnson hopper door.
 Manning, Maxwell & Moore, New York City. Metropolitan injector, air compressors and pneumatic hoists, and Ashcroft steam gauges and consolidated safety valve.
 Mason Regulator Co., Boston, Mass. Air-brake pump governor, balanced valves, pump pressure regulator, steam pump and other regulator appliances.
 Michigan Lubricator Co., Detroit, Mich. Michigan improved triple lubricator No. 3 and automatic steam chest plugs; also air pump cups.

Monarch Brake Beam Co., Detroit. "Monarch" and "Solid" brake beams.
 Moran Flexible Steam Joint Co., Louisville, Ky.
 Missouri Railway Equipment Co., St. Louis, Mo.
 National Coupler Co., Chicago, Ill. Couplers, draft rigging and platform buffers.
 National Malleable Castings Co., Cleveland, Ohio. Tower couplers.
 New York Belting & Packing Co., Limited, New York, N. Y.
 Oval Brake Beam Co., Philadelphia, Pa. Brake beams.
 Pantasote Leather Co., New York.
 Peerless Rubber Manufacturing Co., New York. Air-brake hose, steam hose, engine and tender hose, gas hose, packings, rubber matting, etc.
 Pearson Jack Co., Boston, Mass. Pearson jacks, Pearson kingbolt clamp, Pearson journal jack.
 Pressed Steel Car Co., Pittsburgh, Pa. Pressed steel cars on government tracks east of the Hygeia.
 Q. & C. Co., Chicago, Ill. Chipping, beading and riveting machines, Priest snow flangers, wood car seal.
 Railway Appliance Co., Chicago. Emergency knuckles, car brasses, etc.
 Rand Drill Co., New York, N. Y. Rand compressor.
 Safety Car Heating & Lighting Co., New York.
 Sellers, Wm. & Co., Philadelphia, Pa. No. 6½ automatic injector, model No. 87 improved injector, water strainer; model of 87 automatic machine showing a sectional view, also a full-size No. 87 injector in operation on grounds.
 Simplex Railway Appliance Co., Chicago, Ill. Simplex bolsters for 80,000-lb. capacity cars, also same for 60,000-lb. capacity and short truck bolster for 60,000-lb. capacity cars.
 Star Brass Manufacturing Co., Boston, Mass. Air and steam gauges, chime whistle and pop valves.
 Sterlingworth Railway Supply Co., Easton, Pa. Trucks and brake beams.
 Standard Coupler Co., New York. Standard steel platform, standard coupler—freight and passenger.
 Thornbrough Coupler Attachments Co., Detroit. Draft rigging and coupler.
 Tilden Co., B. E., Chicago, Ill. Railway replacing frogs.
 United States Railway Supply Co., New York. Pottier & Sty-mus Company car seats and Pegamoid leather.
 Universal Car Bearing Co. Chicago car door and universal brasses.
 Walworth Manufacturing Co., Boston, Mass.
 Washburn Coupler Co., Minneapolis, Minn. Couplers.
 Waterbury Tool Co., Waterbury, Conn. Patent ratchet drill.
 Westinghouse Air Brake Co., Pittsburgh, Pa. Air brakes.

CLEANING PASSENGER COACHES.

The appearance of clean and attractive cars is one of the best advertisements available for the passenger departments of railroads. The Modoc Liquid Car Cleaner is highly spoken of by many who are using it and a few suggestions will be valuable to those who are making efforts in this direction.

Cars having run through the shops to be revarnished during the winter will show three or four months' wear and should have immediate attention, as well as those coming out of the shops for general repairs. The great economy is in taking these cars in hand at once, not allowing them to run five or six months before cleaning, for then it will cost as much as though cleaned with soap and water which, often repeated, takes off the paint and varnish and costs an average of \$5 a car, while if cars are cleaned regularly every 30 days after leaving the shops, they can be cleaned for \$1.25 each. Fifty coaches running into any one terminal when treated in this way will always be clean and bright at a cost of \$62.50 per month. Some roads clean their coaches semi-monthly, averaging 8 men to a coach, cleaning 3 coaches every 2 hours, this being done owing to the condition of the road or color of the cars.

It is useless to expect a cleaner to clean dirty coaches as well the first time as with soap and water, because if it was an article containing component parts so strong it would take but very few cleanings to eat all the paint and varnish off and would necessarily contain an acid, alkali or ammonia. The material referred to cleans rapidly enough, as the figures show, after the coaches have had their first cleaning, but if given a fairly clean coach to start with, it is possible to keep it up at the figures above given.

Cars that have been on the road without cleaning from 5 to 6 months get very dirty and should be first cleaned with Modoc powdered soap and then dressed with the liquid, afterwards using nothing but the liquid every 30 days, avoiding the use of water at all times, as it is injurious to varnish and does not clean; in the interim cars should be wiped down with dry or old moistened waste. One can readily figure out the economy in thus systematizing cleaning and not allowing cars to run so long as to necessitate the double expense of cleaning with powdered soap, then dressing with the liquid. Cars treated properly by cleaning regularly, as suggested above, taking them in hand right from the shops, or soon thereafter, will be kept at least 8 months longer on the road, and will always present an attractive appearance.

On cars with the dirt absolutely ground in and the varnish gone, it would be a waste of time and money to clean them with either powdered soap or Modoc liquid car cleaner, as they should go to the paint shop. A large number of cars that are sent to the shops for slight repair work should be given a thorough cleaning with the liquid before being turned out, thus insuring their being in a clean condition at once and they will look like new coaches and can be kept so. The regular and systematic method of cleaning coaches with the liquid should also be adopted for locomotives.

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WIDE FIREBOX CONSOLIDATION LOCOMOTIVES.

Delaware & Hudson Co.

Fifteen consolidation locomotives with wide fireboxes for burning fine anthracite coal have been built by the Schenectady Locomotive Works for the Delaware & Hudson Company, the appearance of which is shown by the accompanying engraving. Ten of these are now in service and are reported to be giving very satisfactory results. The firebox is 10 feet long

page 75. The recent paper by Mr. S. M. Vauclain before the New York Railroad Club and other equally well founded opinions seem to indicate a tendency toward more favorable consideration of wide fireboxes, especially where culm may be used.

The heating surface is 2,564 square feet, 201 square feet being in the firebox. The cylinders are 21 by 26 inches and the weight on driving wheels is 133,000 pounds. The driving wheels are 56 inches in diameter. The boiler is 66 inches in diameter and cylindrical in front of the firebox, which is stayed with vertical stays. The smoke box is short, with just enough room for the cinder pocket in front of the saddle castings.

An unusual arrangement has been adopted for the injector piping, the injectors being both on the right hand side of the engine and the piping is entirely outside of the cab. The air pump and injector steam connections enter the dome by means of angle valves, instead of the usual way of connecting them to a steam box inside of the cab. It is worthy of passing notice that the eccentric rods of this design are very short and that the rocker shaft is placed in front of the main driving wheels. The following table presents the chief dimensions:

General Dimensions.	
Gauge	4 ft. 8½ in.
Fuel	Fine anthracite coal
Weight in working order	153,000 lbs.
Weight on drivers	133,000 lbs.
Wheel base, driving	16 ft. 0 in.
Wheel base, rigid	16 ft. 0 in.
Wheel base, total	24 ft. 2 in.
Cylinders.	
Diameter of cylinders	21 in.
Stroke of piston	26 in.
Horizontal thickness of piston	5 in.
Diameter of piston rod	3½ in.
Kind of piston packing	Cast iron.
Size of steam ports	18 in. x 1¼ in.
Size of exhaust ports	18 in. x 2¼ in.
Size of bridges	1¼ in.
Valves.	
Kind of slide valves	Richardson
Greatest travel of slide valves.....	5½ in.
Outside lap of slide valves.....	¾ in.
Inside lap of slide valves	Line and line.
Lead of valves in full gear.....	Line and line
Wheels, Etc.	
Diameter of driving wheels outside of tire.....	56 in.
Material of driving wheel centers.....	Cast steel
Driving box material	Cast steel
Diameter and length of driving journals.....	8½ in. dia. x 10 in.
Diameter and length of main crank pin journals.....	6½ in. dia. x 6 in.



Consolidation Locomotive with Wide Firebox—Delaware & Hudson Co.

and 8 ft. 6 in. wide, giving a grate area of 90 square feet. This is another example of the tendency toward the use of very large grates for the purpose of burning fine anthracite coal, which may be bought at low prices. The practice of the New York, Ontario & Western in this regard, whereby Mr. West has reduced the cost of locomotive fuel to one-half of the corresponding cost in 1888, is interesting and suggestive of the possibilities for savings where the low grades of fuel are available. Mr. West's practice was described in our issue of March, 1899,

Diameter and length of side rod crank pin journals—Main side, 7 in. x 5¼ in.; F. & B., 5 in. x 3¼ in.; int., 5½ in. dia. x 5 in.
 Engine truck, kind 2-wheel swing bolster || Engine truck, journals | 6 in. dia. x 10 in. |
| Diameter of engine truck wheels | 30 in. |
| Kind of engine truck wheels..... | Steel tired spoke. |

Boiler.

Style Straight with wide firebox || Outside diameter of first ring | 66¼ in. |
Working pressure	180 lbs.
Material of barrel and outside of firebox.....	Carbon steel
Thickness of plates in barrel and outside of firebox.....	¾ in., 11/16 in., ½ in., 7/16 in.
Firebox, length	120 in.

Firebox, width	102 in.
Firebox, depth	53½ in. B., 63 in. F.
Firebox, material	Carbon steel
Firebox plates, thickness, sides, ¾ in.; back, ¾ in.; crown, ¾ in.; tube sheet, 9/16 in.	
Firebox water space	3½ in. front, 3 in. sides, 3½ in. back
Firebox crown staying	Radial stays, 1½ in. diameter
Firebox stay bolts	¾ in. x 1 in. diameter
Tubes, number of	310
Tubes, diameter	2 in.
Tubes, length over tube sheets	14 ft. 0 in.
Heating surface, tubes	2,257.98 sq. in.
Heating surface, water tubes	104.72 sq. ft.
Heating surface, firebox	201.67 sq. ft.
Heating surface, total	2,564.37 sq. ft.
Grate surface	90.05 sq. ft.
Grate, style	Water tubes, dead bars and drop bars
Ash pan, style	Hopper dampers, front and back
Exhaust pipes	Double high
Exhaust nozzles	3¼ in., 3¾ in., 3½ in. dia.
Smokestack, inside diameter	16 in.
Smokestack, top above rail	14 ft. 11½ in.
Boiler supplied by	2 injectors, Nathan & Co. monitor No. 10 Tender.
Wheels, number of	8
Wheels, diameter	33 in.
Journals, diameter and length	5 in. dia. x 9 in.
Wheel base	15 ft. 8 in.
Tender frame	10 in. steel channel.
Water capacity	5,000 U. S. gallons.
Coal capacity	7 tons
Total Wheel base of engine and tender	50 ft. 10¾ in.

CONDENSERS AND COOLING TOWERS.

Exhaust steam under ordinary conditions contains about 90 per cent. of the heat units originally put into the steam in the boiler, and this alone constitutes an excellent reason for utilizing it instead of allowing it to escape into the atmosphere. Besides this the steam is easily made to do further work in the engine by passing it into a condenser, making a saving in the use of steam possible and affording a means of saving from 15 to 20 per cent. in the coal burned. The vacuum on the exhaust side of the piston adds from 10 to 12 pounds to the mean effective pressure, and more work is done with the same amount of fuel, or the same work is done with less fuel. In a paper before the American Institute of Electrical Engineers the late Dr. Chas. E. Emery presented a table from which the following is taken to show the advantages of condensing for different types of engines; this embodies the results of long study and experimenting:

Type of Engine.	Feed Water per Indicated Horse Power Per Hour.				Per cent gained by condens- ing.
Name.	Non-Condensing.		Condensing.		
	Probable Limits.	Assumed for Compari- son.	Probable Limits.	Assumed for Compari- son.	
	Lbs.	Lbs.	Lbs.	Lbs.	
Simple High Speed.....	35 to 26	33	25 to 19	22	
Simple Low Speed.....	32 to 24	29	24 to 18	20	
Compound High Speed..	30 to 22	26	24 to 16	20	
Compound Low Speed.....	.....	.....	20 to 12¾	18
Triple High Speed.....	27 to 21	24	23 to 14	17	
Triple Low Speed.....	.....	.....	18 to 12¾	16

The additional power shown in the increased mean effective pressure is not all clear gain, because some additional work is involved in connection with the condenser, but the gain in economy, as stated, may be expected.

While condensers are as old as the steam engine, until quite recently their attachment has been considered only in connection with plants which were located near sources of an abundant water supply, but recent practice has shown that by comparatively simple means of cooling the water a small amount of water may be used sometimes even to better advantage than a large or even inexhaustible supply, and at present very few steam plants used in connection with electric power stations do not include condensers and water cooling appliances. These are so simple and easy to construct that we wish to direct attention to their advantages in connection with every steam plant that is so located as to give a high or even moderate price for coal.

Whatever form of condenser is employed a cooling system may be considered as generally necessary. Among the different ways of cooling condensing water the following seem to be the most important: (1) Reservoirs of comparatively large area, which are used with advantage where the necessary ground space is available; (2) pools, in which the water

is circulated and caused to cool by surface evaporation; these require somewhat less space than reservoirs, but require circulation of the water; (3) sprays or fountains which deliver the water in finely divided state whereby it is cooled in contact with the air; (4) cooling towers, which are fitted with partitions, nettings, short pieces of tile or other means for greatly increasing the cooling surface, and these are usually fitted with fans for the circulation of air, the water is carried to the top of the tower and allowed to drop over the surfaces; (5) series of pans so arranged that the water will drip from one to the next one below it are arranged in framework supported from the roof of a building and the water allowed to drip through them for cooling by evaporation; (6) the roofs of buildings, which present large surfaces to the air, are sometimes used, the water being distributed from a long pipe with numerous perforations and is afterward collected by means of the ordinary rain water conductors and rain or snow which may fall upon the roof is merely added to the supply of condensing water; and the last system to be mentioned is (7) the evaporative condenser. This device is merely a pipe condenser with large radiating surface, over which water may be allowed to drip and sometimes fans are used to increase the circulation of air:

Before comparing the advantages of the different systems of cooling, attention will be given to the condensers, which may be of either the surface or jet types. The surface condenser, now used so extensively in marine practice, offers the advantage of keeping the condensing water and the steam which is condensed entirely separate. This type is used in cases where it is necessary to return the condensation to the boiler, but it has a serious disadvantage from the fact that the oil carried by the steam from the cylinders of the engine is very difficult to remove. A more or less perfect process of filtration is possible, and while most of the oil may be removed, a little is sure to remain, and frequent and continual additions of even a small amount of oil will cause an accumulation upon the heating surfaces of the boiler that is difficult to remove and is likely at any time to cause a dangerous condition. On the other hand, with the exception of the oil the condensed steam is the best kind of feed water, because it is distilled and will not cause incrustation. The surface condenser requires two pumps, the air pump which is common to all condensers, and is necessary on account of the air entrained in the steam as well as to provide means for removing the condensation and a circulating pump for the purpose of forcing the condensation water through the condenser. In connection with a cooling tower that is elevated upon the roof of a building the surface condenser has the advantage of permitting the circulating water to be moved in what may be termed a closed circuit, in which the injection water from the cooling tower balances the column of water which has passed through the condenser, and the only pumping required is that needed to overcome the friction in the pipes and the head due to the height of the tower itself. Those who advocate the use of surface condensers urge the claim that it is free from the danger of accumulating water from the condensed steam to the point of flooding the engine cylinder in case of a failure of the air pump.

The jet condenser is a very simple pear-shaped casting, very easy to manufacture and maintain, and free from the troubles incident to the large number of tubes in the surface condenser, which must be kept tight. The jet condenser requires but one pump and the injection water is drawn into it automatically by the vacuum. It is a much cheaper device to construct and we think for ordinary use has advantages over the other form. What may be considered a disadvantage of the jet condenser is that the condensed steam and the injection water are mixed, which in the case of bad waters prevents the use of this water in the boiler. The surface condenser may be a little more economical in the saving of heat units on account of the ability to pass the condensed steam into the feed heater

at a higher temperature than is possible with the jet type, but where the feed water is good it will probably pay to allow the condensed steam to make up for the loss in the cooling devices, and as the additions are always more than the evaporation losses the overflow in the jet system may be depended upon to carry away the oil. If the jet condenser is placed 34 feet above the hot well no air pump is required, and it is understood that none is used in connection with the plant of the Hyde Park Electric Company, near Chicago. The jet condenser advocates do not consider the danger of flooding the cylinder as worthy of attention, as the construction is generally made to insure the destruction of the vacuum in case the air pump fails to take away the injection water fast enough.

In considering the arrangements for cooling it may be said that the temperature of the water should not be above about 100 degrees F. in order to get a good vacuum, and the cooling water may easily be brought down to that temperature by a good arrangement of any of the plans mentioned.

The pool system has been used to a considerable extent in electric plants. A modification of it as applied on the Chicago, Milwaukee & St. Paul Railway was illustrated in the "American Engineer" of March, 1898, page 87. From successful practice it seems to be advisable to allow about 45 square feet of radiating surface per indicated horse power of the engine if the engine uses about 20 pounds of steam per indicated horse power per hour, and it is necessary to provide a circulation of the water in the pool so that the maximum radiating effect may be obtained. The pool system has been used at Hollister and Oakland, Cal.

The spray system is a convenient one and is one of the cheapest to construct. At a planing mill at West Berkeley, in California, the water for an 80 horse-power engine is raised by the air pump and passed through a spraying pipe falling 12 feet to a trough below, where it is collected and runs into the condenser at the end by gravity.

Towers are made in various forms, and they may be had ready made from the builders of condensers and steam pumps, an excellent one being described in a paper by Mr. Louis R. Alberger, read before the American Society of Mechanical Engineers in 1896. Towers with wooden spreading surfaces, occupying a space of 14 by 21 feet, have been found capable of cooling about 4,500 gallons of water per hour, which may be considered sufficient for an ordinary engine of 200 horse-power (there seems to be no definite rule as to the amount of cooling water required). In another case the water for a 250-horse-power engine has been cooled in a tower 15 by 22 feet in size and about 25 feet high, which will handle approximately 6,000 gallons per hour. The large tower for the "Alley L" Railway, in Chicago, with a sufficient capacity for 7,200 indicated horse-power, occupies a space 16½ by 64 feet and 34 feet high. These towers require fans for air circulation, and they consume about 1½ or 2 per cent. of the power of the main engine. In another case a tower 6 by 7 by 20 feet and a 50-inch ventilating fan was found capable of cooling 10,500 gallons of water per hour from 104 to 66 degrees, and it will be seen from these figures that a great deal depends upon the efficiency of the cooling surfaces in the tower; also climatic and other conditions are important.

The roofs of buildings seem to offer a favorable cooling surface and are used in England. It is clear that when a large cooling surface is necessary the water may be distributed near or at the top of the roof, and other pipes nearer the bottom may be used to distribute it in cold weather when less surface is needed. There need be no danger of freezing in these pipes, because while in use the water is warm, and the piping system may be drained when not in use.

The pan system has been successful when from 15 to 23 square feet of surface per indicated horse-power is provided. Reservoirs may be considered as out of the question for most cases, but when used it may be considered sufficient to provide

about 25 square feet of surface area of the water per indicated horse-power per hour when the engine is using 13 pounds of steam. This figure is given by Mr. H. W. Barker, in a paper before the Institution of Civil Engineers. He also states that a compound engine using 16 pounds of steam requires 31 square feet, and a single cylinder engine, using 20 pounds, requires 39 square feet per indicated horse-power.

The evaporative condenser at first sight seems to have much to recommend it, but it has not made very much progress in this country. By its use the cooling water may be reduced to an amount below that of the boiler feed, and yet a good vacuum may be had; in this way it is possible to actually reduce the total amount of water used and yet secure the advantage of condensation. We think that the difficulty of keeping the condenser tight will prove a serious obstacle. The space required for one of large capacity and the great weight of the apparatus are other serious objections.

PROPOSED RAILWAY CONSTRUCTION IN FORMOSA.

Consul James W. Davidson writes from Tamsui, June 6, as follows:

I have been unable as yet to obtain any detailed information regarding the new railway line to be constructed in the island, as Chief Engineer Hasegawa, the officer in charge, is at present in the south. Only \$1,000,000 has been appropriated for the year's work, and I am informed by the chief of the communication department, it will be expended as follows: Work will be at once commenced at Takow on the Takow-Tainan branch, a line 28 miles in length. The land is quite level, and the work presents no difficulties save the bridging of two small rivers. Trains will be running over the Takow branch in two years.

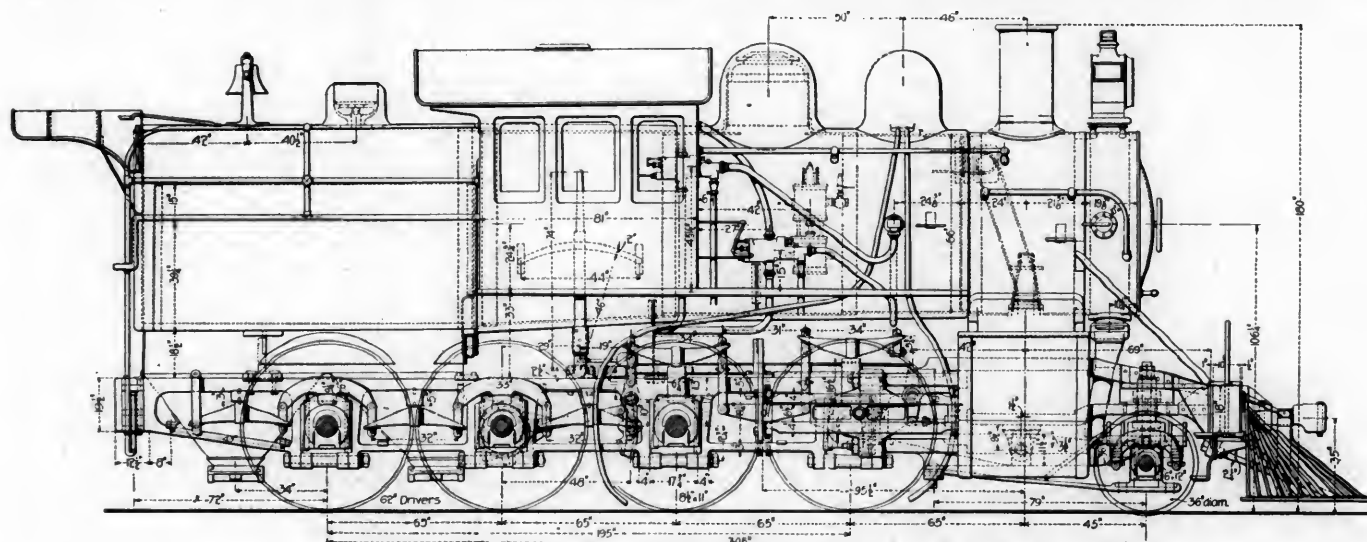
The present northern line runs from the Tamsui River in a southerly direction 40 miles to Hsinchiku (Teckcham). It was built by the Chinese and completed in 1893. From the Tamsui River opposite to Twatutia, the foreign settlement, the line runs over nearly level ground for some 7 miles. It then ascends a table-land, on a maximum gradient of 1 in 30, and for the rest of the distance, with the exception of a few miles outside of Hsinchiku, it zigzags through the hills on the right side of a picturesque valley, up and down grade as though built on the model of a corkscrew. It has always been unsatisfactory, and portions of the line have been frequently destroyed by storms and freshets. Formerly, a bridge across the Tamsui River permitted the trains to run into Twatutia; but this, as well as several bridges a few miles from Hsinchiku, were destroyed during last year's great typhoon, one large iron bridge being carried 87 yards by the force of the wind and current. At present, therefore, the line does not touch either of the original terminals.

The Japanese find that this line must be almost entirely rebuilt. A new bridge nearly 2,000 feet in length and costing some 800,000 yen (\$400,000) will be constructed across the Tamsui River at Twatutia, and the route will follow in a general way the original road, though while passing through the hills it will be on the left side of the valley and by the aid of two tunnels and many cuttings will be much straighter than the old line. The bridge will be commenced this year, and the line probably finished in two years. From Hsinchiku (Teckcham) to Tainan is 145 miles, and it is the intention to build the railway between these two points as soon as the work mentioned above is completed. This line will require numerous and expensive bridges and some thirteen tunnels. When completed it will give a railway service from Kelung to Takow, a distance of 205 miles.

I am pleased to be able to state that the chief of the communication department informs me that in all probability the locomotives, rails and bridge material will be obtained from the United States, and that the order will, he believes, go to the Carnegie Company, of Pittsburg. I am unable at present writing to give information as to the extent of this order, but will write on the subject later. The gauge of the present line is 3 feet 6 inches, the rails 36 pounds, and the ten locomotives used are of English and German manufacture. The new locomotives will be heavier than the ones at present employed, and the rails 60 pounds.



Baldwin Compound Consolidation Locomotive—Lehigh Valley R. R.



Baldwin Compound Consolidation Locomotive—Lehigh Valley R. R.

VAUCLAIR COMPOUND VS. SIMPLE LOCOMOTIVE WITH PISTON VALVES.

Lehigh Valley.

Many comparative tests have been made between compound and single expansion locomotives, and usually efforts are made to render the comparisons fair to both types, especially in regard to boiler power and steam pressure; but Mr. Higgins, Superintendent of Motive Power of the Lehigh Valley, has gone further than anyone else in this direction by giving both types exactly the same boilers and boiler pressure and piston valves. It is well known that an experiment on the Norfolk & Western Railway proved that an engine, originally a compound, when given single expansion cylinders and piston valves, beat its own previous record as a compound. Mr. Higgins' experiment is noteworthy because every possible advantage was given to the single expansion engine, and thoroughly well balanced valves exert an important influence on power and the economy.

Four tests were run with engines Nos. 801 and 802 between Buffalo and Sayre. The engines are alike in every respect except the cylinders and weights. The cylinders of the simple engine are 21 by 30 inches. No. 802, the compound, weighs 171,000 lbs. on driving wheels and 24,000 lbs. on the truck wheels, while No. 801 weighs 167,000 lbs. on the drivers and 20,000 lbs. on the truck. The tenders weighed 100,000 lbs. in working order. We described and illustrated the compound in our issue of April of the current volume, but for convenience and because of the interest in the test, the diagram of the design is reproduced.

During the tests stops were made at points on the division where it was known to be most difficult to start trains, and it was found that the compound always started without taking up the slack between the cars. Engine No. 801 started the trains from these points, but it was necessary to take up the slack several times, which showed the advantage possessed by the compound in starting. There was a decided difference in the steaming qualities of the engines in favor of the compound. The boiler pressure was 200 pounds in each case. In computing the results the net tonnage does not include the weight of the engines and tenders. Both engines were designed by the railroad company, under the direction of Mr. Higgins, and they were built by the Baldwin Locomotive Works.

This design was prepared specially for the Buffalo division, where there are long grades, one of which is 21 feet per mile and 37 miles long; and another 18 feet per mile and 30 miles long. The engines were built to pull 2,000 tons, not including the engine and tender, and each was to do the work which formerly required two of the locomotives previously used on that district.

The tests were carried out with exceptional care and the results leave no doubt as to the advantage of the compound both in fuel economy and in convenience in operating. The fuel used was a mixture of 80 per cent. buckwheat and 20 per cent. bituminous. The speeds when the pairs of runs are compared are very nearly the same and there were no differences in the rail or weather conditions. The cars were all loaded and when the runs are paired the trains are seen to be very nearly alike in weight. It would be difficult to secure more comparable conditions in road tests. Taking the average results the compound showed an advantage of 13.4 per cent. in fuel per ton

mile and as a result of the tests the Lehigh Valley Railroad has ordered 23 Vauclain compound locomotives like No. 802.

A summary of the results and a brief table of dimensions of the locomotives are given below:

VAUCLAINE COMPOUND LOCOMOTIVE COMPARED WITH SINGLE EXPANSION LOCOMOTIVE HAVING PISTON VALVES.
LEHIGH VALLEY R. R.

Test number	1	2	3	4
Engine number.....	802	801	802	801
Date	May 23	May 24	May 25	May 26
Distance in miles.....	172	172	172	172
Controlling grade.....	21.63 ft.	21.62 ft.	21.62 ft.	21.62 ft.
Atmospheric pressure.....	65 deg.	70 deg.	70 deg.	67 deg.
Tonnage, net.....	2,193	2,196	2,002	1,990
Number of cars	61	57	47	49
Loaded cars	61	57	47	49
Cars less than 60,000 lbs. capacity.....	20	8	0	0
Cars of 60,000 lbs. capacity.....	40	48	46	48
Average load per car, tons.....	35.95	38.53	42.59	40.60
Departure from E. Buffalo.....	7:04 A. M.	7:04 A. M.	9:35 A. M.	9:09 A. M.
Arrival at Sayre.....	9:03 P. M.	9:08 P. M.	9:15 P. M.	9:20 P. M.
Running time.....	10 h., 23 m.	10 h., 0 m.	8 h., 51 m.	9 h., 12 m.
Average speed, miles per hr.....	16.56	17.20	19.43	18.70
Fuel used, in tons.....	16.29	17.66	11.85	14.7
Fuel used per ton mile, lbs.....	0.0864	0.0935	0.0688	0.0858
Water used, gals.....	24,783	25,553	21,139	22,935
Water evaporated per lb. fuel, lbs.....	6.33	6.03	7.43	6.50

Cylinders, compound	17 and 28 by 30 in.
Cylinders, simple	21 by 30 in.
Driving wheels, over tires	62 in.
Rigid wheel base	16 ft. 3 in.
Total wheel base	25 ft. 5 in.
Height from rail to top of stack	15 ft.
Boiler pressure	200 lbs.
Boiler diameter	66 in.
Heating surface, firebox	177.7 sq. ft.
Heating surface, tubes	2,809.6 sq. ft.
Heating surface, total	2,987.3 sq. ft.
Firebox, length	118 in.
Firebox, width	96 in.
Tubes, 358, two inch, length	15 ft. 1 in.
Piston rods hollow, diameter	4½ in.
Driving journals	8½ by 11 in.
All drivers flanged	
Engine truck wheels	36 in.
Water capacity of tender	4,500 gals.

MR. QUAYLE'S PRESIDENTIAL ADDRESS.

Master Mechanics' Association.

The following suggestive review of the motive power situation is abridged from the address of President Quayle before the Master Mechanics' Association, at Old Point Comfort:

"Since our last convention we have seen a very marked advance in the weight and power of locomotives, both passenger and freight. More powerful locomotives are necessary, and yet the track must not be made to suffer; and this, I believe, may be accomplished. We may need to increase wheel loads somewhat, but by using larger driving wheels the counterbalance weights may be made even less destructive than small wheels with lighter loads. We ought to build engines that will haul at least 2,000 tons on grades of from 0.6 to 0.7 of 1 per cent., and instead of driving wheels of 55 inches for road engines, on lines with ruling grades less than 1 per cent. we ought to use 60 inches. On such roads, by increasing train loads from 1,500 to 2,100 tons, we ought to save not less than half the cost of the heavier engine per year.

"The greatest possibilities in saving, by the use of more powerful locomotives, are in the wages of engine and train crews. The expense of running a freight train for trips of about 100 miles at ten miles per hour, which is uniform regardless of weight of train and the grades, is about \$22. The cost of coal will be less per ton mile for heavier trains, but it is this constant charge for crews which affects the saving when their number is reduced. The labor cost at the round house will be somewhat greater per engine mile, but when compared, on the basis of ton miles it must be less, even when the labor of wiping is included. The wages of engine dispatchers are the same for heavy as for light engines, but since a smaller number are required for a given amount of work, this expense should be less with those that are more powerful.

"The saving in coal is next to that of labor, and within the

proper limits of the capacity of the engine and of speed, the heavier the train the less coal is required per ton mile. This argument applies to the loading of engines, whether heavy or light, but its force is greatest in connection with very powerful locomotives. This may be demonstrated by coal reports kept for relatively long periods. It takes more oil to lubricate a heavy engine than a light one, but this, too, should be referred to the ton mile, when it appears as a saving in spite of the great increase in steam pressure and the dimensions of journals. The same holds true in regard to the cost of repairs. They also will increase, but not in proportion to the additional work done. With two engines operating on the same grades, one built to haul 600 tons and the other 900 tons, the relative total cost of operation per 1,000 ton miles may be taken as the ratio of about 47 to 36, or a difference of about 25 per cent., or more than is usually expected from compounding.

"The tendency toward heavier loading has been favorable to compounds, because of the possibilities of greatly increasing their pulling power at critical points on summits by the use of live steam in the low-pressure cylinder.

"The possibilities of lightening parts by the use of improved material, whereby capacity may be increased without increasing weight, should be utilized to the utmost. Larger boilers may be built without increase of total weight, and we may be encouraged in this by the great improvement of recent years in marine work.

"It would take too long to do more than partially enumerate the directions in which we may improve locomotives. The following need our attention: The reduction of waste power of the cylinder by reducing back pressure and condensation; piston valves; feed water purification; the forms of fireboxes and other factors tending to reduce staybolt strains and failures; more thorough lagging of the boilers at the sides and front of the firebox; the further use of cheap fuels and care in the matter of details which will prevent engine failures on the road. All of these subjects are before us and all of them give promise of good returns for the time and money spent upon them.

"The distribution of power in shops needs thought. We have electricity, compressed air and also the gas engine to aid us, and I predict that after ten years we shall look back with surprise at the prevailing shop power methods of the present. We need more power cranes and more modern and powerful tools. We must give more attention to the cost of work and to those commercial methods that make success or failure in manufacturing establishments. The welfare and comfort and the surroundings of our men, both on and off duty, interest us now, but much more ought to be done in these matters in the lines of reading rooms, places of recreation, and in providing lectures, instruction and entertainment. We should use the technical papers intelligently. It is a good plan for the head of the motive power department to mark articles and send them to the master mechanics and such other employees, as they may deem wise, asking for comments and suggestions."

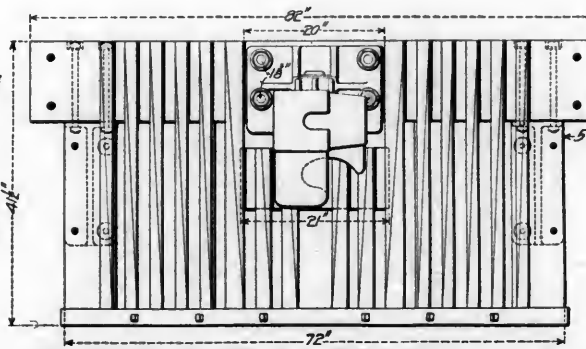
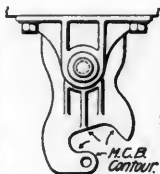
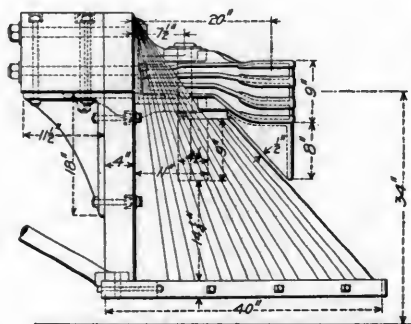
NEW CARS FOR THE EMPIRE STATE.

Some of the new coaches for the Empire State Express of the New York Central have been placed in service and are very handsome. They have a capacity for 85 passengers, while those heretofore in use accommodated only 65. This will make it possible to carry a greater number of passengers on this train, and take care of all who seek its advantages. The new cars have six-wheel trucks and full width vestibules, with anti-telescope steel platforms. The interior finish is inlaid mahogany, the carvings and decorations being in entire harmony. The seats are highbacked, and the car roof is dome shaped, its decoration being in green and gold.

TITLE INSCRIPTIONS ON DRAWINGS.

In the routine of the drawing office the work of placing titles on tracings is a matter of considerable importance and causes a great sacrifice of time when done by hand, no matter how expert the artist may be at either freehand or instrument work. This fact, taken in connection with the lack of uniformity in hand work, has led to devising schemes by which a title may be quickly printed on a drawing, and at the same time give a creditable appearance and also preserve a distinctly uniform style. All this is accomplished by means of moveable type easily set in a frame, and while the results are not of the ornate order so dear to some draughtsmen, they are less costly and serve the purpose perfectly. In reply to our inquiry of Mr. F. M. Whyte, Mechanical Engineer of the Chicago & Northwestern Railway, for his practice in this line, Mr. Whyte writes as follows:

"In regard to the use of a printing press for printing titles on tracings, we are using a small handpress for this purpose, the frame of which measures 4 by 6 inches. When it was first proposed to purchase a printing press the one we have was considered sufficiently large; but it has been remarked several times since that it would have been better had we purchased a larger one. The length of the frame given above limits the length of the title, but we find it large enough for the purpose, as we try to make the title as short and expressive as possible. We have three fonts of type, and you can judge of their size by the attached print. We find these sizes of type convenient and quite satisfactory. I might tell you



Locomotive Pilot Coupler—Northern Pacific Ry.

our experience which practically drove us to the adoption of a hand press. First, of course, it costs considerable to put titles on drawings whether the work is done with the usual drawing instruments or by freehand. To reduce this cost, we tried first to use a rubber stamp, but the ink which we found would work satisfactorily with the rubber stamp would not give a print, so that, after putting the title on with the stamp, we would have to turn the tracing over and ink it on the back with black drawing ink. This, of course, was no great improvement on putting the titles on by hand. We found we could not use black ink on the rubber stamp, because the gasoline used for removal of the ink from the stamp after using it would destroy the rubber type. It was also difficult to get a perfect impression with the rubber stamp. The first difficulty experienced with the hand press was that the ink would not dry fast enough after the title had been put on the tracing, but this trouble was overcome by using a light, fine powder to absorb the ink, so that we now take a print from the tracing immediately after titling it. Fine powder should be used, because, otherwise, the large flakes of coarse powder will overhang the edge of the letter and produce ragged edges. We use the ordinary quick-drying printers' ink for our press. The first cost for us was \$22.50 for the complete outfit, and it is believed that the first month or two's saving would cover

The style of letter and general appearance of this method

Y. X. & Z. RY.

CYLINDER, 18"X24"

PATTERN DRAWING

CHICAGO, ILL.

JAN. 5, 1899.

APPROVED

CORRECT

SUPT. M. P.

MECH. ENGR.

4567

of lettering may be noted from the example furnished in our illustration, which is reproduced from the sample sent us. It is not a work of art, but it is fitting for the purpose, and the practice indicates an intention to get the greatest possible value out of the drawing office force.

LOCOMOTIVE PILOT COUPLER.

Northern Pacific Railway.

The standard pilot of the Northern Pacific Railway is shown herewith, together with the steel coupler as now used, which has replaced the cast iron drawhead, for a long time a standard

of that road. The casting seen under the coupler is a guard to prevent stock from being wedged between the pilot and coupler. This guard or shield was cast solid with the pattern of drawhead, but is bolted under the new coupler and swings laterally with it, just clearing the pilot slats. The coupler does not uncouple, having simply the M. C. B. contour lines, but no knuckle. It has a limited lateral movement and is held in the central position by springs.

The steamship "Deutschland," now building for the Hamburg-American Line at the Vulcan yards near Stettin, Germany, will be faster and larger than the North German Lloyd liner "Kaiser Wilhelm der Grosse." The new vessel will have an average speed of 23 knots, her length over all will be 686½ feet, length on water line 662 feet, beam 67 feet 4 inches, draft 29 feet, and displacement 22,000 tons. Her engines are to maintain 35,000 horse-power. The boiler pressure will be 225 pounds per square inch and the twelve double and four single boilers will have a total of 112 furnaces. The specifications call for 23.12 knots on the trial and 23 knots sustained speed. The ship is expected to be ready for service early next summer. While not as large as the new White Star liner "Oceanic," the speed will be much greater. The German ship will accommodate 736 first class, 300 second class and 282 steerage passengers, a total of 1,320.

SIMONS DRAFT RIGGING FOR STEEL CARS.

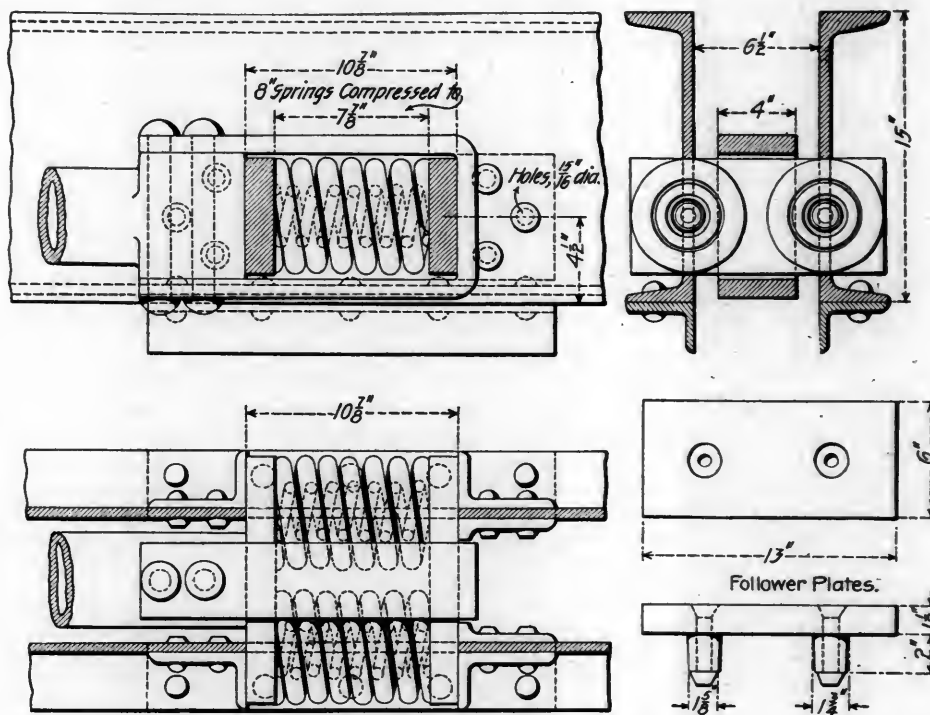
Mr. J. E. Simons, Assistant Master Car Builder of the Pittsburgh & Lake Erie, has given a great deal of attention to the improvement of draft attachments in order to keep these parts up to the requirements imposed by the increasing severity of the demands upon them. Draft gear for large cars needs attention in three directions: 1. Increased spring resistance to receive and cushion all the draft stresses without closing up. 2. Stronger attachments to receive the thrusts of the followers, and 3, more direct transmission of the stresses from the coupler to the underframe of the car.

In the draft gear, designed and patented by Mr. Simons, which is illustrated here, these features have all received at-

LOCOMOTIVES IN GERMANY.

Germany has eighteen shops turning out locomotives both for home and foreign use, according to a recent letter from Consul J. C. Monaghan, from Chemnitz, fifteen of these build both large and small engines, and three build nothing but small ones for light work. These can furnish annually, under normal conditions, 1,400 engines. They employ from 15,000 to 20,000 workmen—the number depending upon the orders. Germany exports locomotives to Russia, Sweden, Norway, Denmark, Turkey, South America, South Africa and Asia. A house here sent nineteen a year or two ago to the Dutch East Indies.

Up to date, as far as can be found out, no United States en-



Simons' Draft Gear for Steel Cars.

tention, but particularly the last two. The center sills are I beams, through the webs of which slots are cut to receive the follower plates and the draft springs, the springs being centered to bring the stresses directly upon the webs of the sills, indicated in the drawing. The webs are too narrow to give sufficient bearing area for the followers, and angles are riveted to them to increase the bearings, and short angles are riveted to the bottom flanges of the center sills in order to compensate for the amount of material cut away from the webs.

Mr. Simons uses double draft springs and from his remarks before the M. C. B. Association at Saratoga in 1898 it is evident that he appreciates the necessity for increasing the spring resistance of draft gear. He directed attention at that time to the fact that the draft of long trains of heavily loaded cars of large capacity caused the draft gear to close up solid instead of carrying the stress with the elasticity of the springs. He has succeeded in getting the stresses into direct line with the resistance of the sills. He avoids the use of eccentrically loaded draft lugs altogether, and the few rivets used are well disposed and are not in tension.

"When taking his first step from college it is most important to shun influential friends who have it in their power to place you in positions beyond your experience; remember it is just as important to progress step by step in the practical work in your profession as it is to follow your regular course in the university."—[Mr. John Stirling Deans' address before the students of Lehigh University.]

gine, says Mr. Monaghan, has entered this Empire, although England has ordered a number. A writer, whom I quote freely, says that work can be more effectively done in the United States, because only a few well tried forms of engines are made. "In consequence of this," he continues, "the parts are put up and kept in supplies by all parties acting as agents of such engine builders. This enables those buying American engines to replace broken or injured parts almost instantly." German writers say the firms in Europe could do the same in the time put down for delivery, etc., were it not for the fact that every railroad company, every engineer, wants a particular type. They go so far as to express preferences for different kinds of different parts, and every change of officials or engineers having charge of the purchase of locomotives or their parts brings change in the articles used. Consequently, Germany has found it impossible to keep a supply of parts. "This," says the writer referred to, "may keep Germans from overproduction, etc., but it has the disadvantage of delaying deliveries. An understanding among the builders of locomotives might lead to a system not only advantageous to the Empire, but useful to the exporters of locomotives. It would help to keep territory already captured in far-off lands and fit Germany to meet America's rapidly rising influence."

"It is hardly necessary to say that American locomotive builders will do well to look these lines over. They have never had such a chance as now. All Asia, Africa, Australia, North and South America, many states of Europe, particularly Russia, offer markets which we are the only people fully equipped to supply."

AIR BRAKE DECISION:

Westinghouse vs. New York.

The United States Court of Appeals for the Second Circuit handed down a decision July 18 in the suit of the Westinghouse Air Brake Company against the New York Air Brake Company for the infringement of certain claims of patents No. 538,001, granted to George Westinghouse, and 382,032, granted to Theron S. E. Dixon. The suit was first tried before the circuit court and won by the defendants. The appeal resulted in sustaining the decision of the lower court. The opinion was written by Judge Shipman and concurred in by Judge Thomas, while Judge Lcomb dissented as to the infringement of patent No. 538,001 and agreed with the others as to the Dixon patent. The opinion is too long to be reproduced in full, but a brief abstract will be interesting as a matter of record.

It is recognized that the success of the air brake is based upon the promptness of the reduction of the train pipe pressure and the equalization of the pressure in the brake cylinder and the auxiliary reservoir. Formerly the venting was all done at the engineer's valve, and the quick action feature was added by Westinghouse by venting at each triple valve in emergency applications, in addition to the venting at the engine, which resulted in greatly hastening the action. Westinghouse also saved air and augmented the brake power by venting the train pipe into the brake cylinder at each triple valve, thus utilizing the vented air for obtaining the initial charge of the brake cylinder. This emergency action was inaugurated by a large reduction of train pipe pressure at the engineer's valve, which effected the venting at the triples by means of a "further traverse" of the triple valve piston beyond the traverse employed in ordinary service applications in the first form devised. On account of the comparatively small air ports which were thus opened by the "further traverse" the brake was improved by the use of a supplementary piston to operate the valve controlling the emergency passage, and in both cases the venting from the train pipe to the cylinder was controlled by the "further traverse" of the piston of the triple valve.

In 1892 a further improvement was made and a compound piston was employed, which was connected with the brake cylinder piston, which took the place of the "further traverse" of the triple valve piston to uncover the emergency port. The speed of the operative piston rather than its length of movement being the means by which the vent valve was opened. This patent was applied for in 1892 and it remained in the patent office for three years on account of changes in claims. The court says that no claim was made for a broader scope of this patent than that of covering a method of venting air to the brake cylinder until March, 1895, when the defendants called the complainants' attention to a method proposed by them for venting the train pipe to the atmosphere. This led to the addition of six new claims to the patent application of 1892, which were allowed, and by which the scope was enlarged to make them apply to venting to the atmosphere.

The complainants contended that the invention was of a broad and primary character, covering the arrangement for operating a vent valve whereby the opening depended on the rate or manner of movement of the primary part of a compound piston. The defendants held that the mode by which the train pipe is vented to the brake cylinder constituted the scope of the invention, while the complainants claimed that the operation to locally exhaust the air independent of the subsequent disposition was covered by their patent.

The court said that Westinghouse did not contemplate venting to the atmosphere or to a separate chamber and did not show how this could be accomplished; furthermore, the progressive history of the invention had shown that such delivery was not considered as the most beneficial for quick action brakes while the desired object was to obtain increased brake cylinder pressure because of the venting of the train pipe into

it and giving greater speed and force to the application of the brakes.

The opinion of the court was that while venting to the atmosphere was suggested in the complainants' patent, yet the means where atmospheric venting could be accomplished in the quick acting air brake would require invention and was not covered by the claims. Furthermore, Westinghouse confined himself to the use of the vented air in the cylinder. If the question depended on the restriction of the Westinghouse claims to the mechanism shown there was no infringement. On this point the opinion says: "We are therefore of opinion that the claims inserted by amendment of 1895 must be limited to a piston attached to or moved by the brake cylinder piston for venting the train pipe into the brake cylinder."

The defendants' valve designated as "Valve C" vents into the atmosphere, using a compound piston, which is a part of the triple valve piston, the action of which is not a part of that of the brake cylinder piston, the service and emergency operations being obtained by varying speed, using methods similar to those of the Westinghouse patent of 1895.

This patent was judged not to have been infringed.

The Dixon patent employed a single piston, which in its preliminary traverse moved only far enough to open a valve to admit air from the auxiliary reservoir to the brake cylinder, while its further traverse, caused by an emergency application, opened a vent valve from the train pipe to the atmosphere. A valve was added to close that vent opening by means of another piston, which was actuated by air pressure from the brake cylinder when the cylinder pressure became sufficiently great for the purpose. The Dixon patent was, in general, similar to the first Westinghouse quick acting patent, No. 360,070, except that Dixon vented into the atmosphere. The New York triple has a compound instead of a simple piston and does not use the preliminary traverse.

In the opinion of the court it was held that the invention of the Dixon patent is a subordinate one, which consists in using the venting mechanism similar to the Westinghouse quick action patent, No. 360,070, but which provides that the air vented from the train pipe shall pass direct to the atmosphere instead of to the brake cylinder and necessarily includes additional mechanism for closing the train pipe vent valve at the proper time. The court holds that the mechanism by which the train pipe vent valve of the defendant's triple valve is opened is of a different character from that employed in the Dixon patent in that a compound piston of a single range of movement is used where Dixon employed a simple piston of two ranges of movement. In a subordinate patent no such broad range of equivalents could be granted as would include the defendant's compound piston within the scope of Dixon's piston arrangement.

Westinghouse contended that the character of the Dixon patent was sufficiently broad to include the use of the defendant's compound piston as an equivalent of Dixon's. The court seemed to regard this as the turning point of the case as far as the Dixon patent was concerned and decided that the invention was not one of sufficiently primary importance to warrant such a construction. The court held that the Dixon patent had not been infringed.

Thus in both cases the decision of the lower court was sustained.

If you were told of a steam plant with a boiler capacity of 4,000 horse-power, with electric generators capable of developing 1,500 kilowatts, with 25,000 electric lights, with a refrigerating plant having a cooling capacity equal to the melting of 150 tons of ice per day, with pumps sufficient to handle the water supply for a city of 400,000 inhabitants, a plant which has 152 steam and 102 water cylinders and 56 electric motors, and a force of 116 men in the engineers' department, would it occur to you that it was simply the mechanical plant of a hotel? All this and more is true of the Hotel Waldorf-Astoria in New York City.—"Power."

HEAVY TEN-WHEEL PASSENGER LOCOMOTIVES.

New York Central.

The New York Central has received several locomotives of the ten-wheel type of a lot of ten from the Schenectady Locomotive Works, which, with the exception of the Brooks simple 10-wheel engines built in 1898 for the Great Northern, and the Schenectady compounds of the same type for the Northern Pacific, are the heaviest passenger locomotives of which we have record. The comparison of weights is as follows:

	N. Y. C.	Gt. N.	N. P.
Weight total.....	164,000	166,000	172,500
Weight on drivers.....	126,000	129,000	126,000

The New York Central engines have cylinders 20 by 28 inches, driving wheels 70 inches, and the driving journals are 9 by 12 inches. The heating surface is 2,886 square feet, which is within 9 square feet of that of the Northern Pacific compound already referred to. These compounds have 2,895 square feet of heating surface, which is the largest in passenger service. Other dimensions are included in the table given below. These engines will be used on the fast trains between New York and Buffalo, and it is understood that they were ordered before the recent changes in the heads of departments on the road.

Thickness of plates in barrel and outside of firebox,	21/32 in., 3/4 in., 1/2 in. and 11/16 in.
Firebox, length	108 1/4 in.
Firebox, width	40 3/4 in.
Firebox, depth	F. 83 1/2 B. 71 1/2 in.
Firebox, material	Carbon steel
Firebox plates, thickness.....	sides, 5/16 in., back, 3/8 in., crown, 1/2 in., tube sheet, 1/2 in.
Firebox, water space	4 1/2 in. front, 3 1/2 in. sides, 3 1/2 to 4 1/2 in. back.
Firebox, crown staying	Radial stays 1 1/2 in. diam.
Firebox, stay bolts	1 in. in diam.
Tubes, material	Charcoal iron No. 11
Tubes, number of	360
Tubes, diameter	14 ft. 4 in.
Tubes, length over tube sheets	2,685.99 sq. ft.
Heating surface, tubes	12.64 sq. ft.
Heating surface, water tubes	187.53 sq. ft.
Heating surface, firebox	2,886.16 sq. ft.
Heating surface, total	30.32 sq. ft.
Grate surface	Double high
Exhaust pipes	3 1/4 in., 3 3/8 in., 3 1/2 in. dia.
Exhaust nozzles	16 1/2 in.
Smoke stack, inside diameter	14 ft. 9 1/4 in.
Smoke stack, top above rail	2 Monitor injectors
Boiler supplied by	

Tender.

Weight, empty	45,500 lbs.
Wheels, number of	8
Wheels, diameter	33 in.
Journals, diam. and length	4 1/2 in. dia. x 8 in.
Wheel base	15 ft. 10 in.
Tender frame	10 in. channel iron
Water capacity	4,500 U. S. gallons
Total wheel base of engine and tender.....	52 ft. 8 3/4 in.
Tender fitted with water scoop.	
Coal capacity	10 tons



10-Wheel Passenger Locomotives—New York Central & Hudson River R. R.

General Dimensions.

Gauge	4 ft. 8 1/2 in.
Fuel	Bituminous coal
Weight in working order	164,000 lbs.
Weight on drivers	126,000 lbs.
Wheel base, driving	14 ft. 8 in.
Wheel base, rigid	14 ft. 8 in.
Wheel base, total	26 ft.

Cylinders.

Diam. of cylinders	20 in.
Stroke of piston	28 in.
Horizontal thickness of piston	4 1/2 in. and 5 in.
Diam. of piston rod	3 3/8 in.
Kind of piston packing	3 cast iron rings
Size of steam ports	18 in. x 1 1/4 in.
Size of exhaust ports	18 in. x 2 3/4 in.
Size of bridges	1 1/4 in.

Valves

Greatest travel of slide valves	5 1/2 in.
Outside lap of slide valves	1 in.
Inside lap of slide valves	0 in.
Lead of valves in full gear	0 in.

Wheels, Etc.

Diam. of driving wheels outside of tire.....	70 in.
Material of driving wheel centers.....	Cast steel
Driving box material	Cast steel
Diam. and length of driving journals.....	9 in. dia. x 12 in.
Diam. and length of main crank pin journals.....	6 in. dia. x 6 in.
Diam. and length of side rod crank pin journals,	
Main side 6 1/4 in. x 5 1/4 in. F. & B. 5 in. dia. x 3 3/4 in.	
Engine truck, kind	4-wheel swing bolster
Engine truck journals.....	6 1/4 in. dia. x 10 in.
Diam. of engine truck wheels	33 in.
Kind of engine truck wheels	Krupp steel tired spoke with 2 1/2 in. tire

Boiler.

Style	Extended wagon top
Outside diam. of first ring	66 5/16 in.
Working pressure	200 lbs.
Material of barrel and outside of firebox.....	Carbon steel

ELECTRIC VS. STEAM TRACTION.

At the recent annual meeting of the American Society of Civil Engineers, at Cape May, N. J., the following topic was presented for discussion:

"What are the economic conditions under which electricity may be profitably substituted for steam in the operation of branch railroad lines, and what are the engineering requirements to be considered in such substitution?"

Col. H. G. Prout, Editor of the Railroad Gazette, stated the case clearly and forcibly by showing that the question was purely one of traffic conditions. Except for frequent, short trains doing a suburban business or street railway business, there was no advantage in electricity so far as the cost of power was concerned. A 1,000-horse power locomotive costs \$10,000, while a stationary power house plant of equal capacity costs about \$80,000, and any gain in the fuel economy through the use of the electric motor would be more than offset by the greater first cost of the plant. The fuel cost was a small item in the total expense of operating, and the advantage of the electric motor over the locomotive, if any existed, must be sought in other directions than in fuel economy.

This is a clear statement of fact and it ought to cause advocates of electric traction to trunk line service to subside until such service becomes suitable for electric subdivision of power, or, in other words, until "the train service becomes so frequent and steady as to resemble the movements of buckets upon a grain elevator."

FAVORABLE ENGLISH OPINIONS OF AMERICAN LOCOMOTIVES.

The following extracts from an editorial in "The Engineer," of London, July 7, 1899, are interesting to those who have followed the recent march of events in locomotive practice, with particular reference to the use of American designs in foreign service:

If a railway was absolutely smooth, level, straight and unyielding, springs would be wholly unnecessary. The worse the road the greater is the need for flexibility and elasticity. It is an open secret now that in certain trials which took place a good many years ago in France, between French and English locomotives, the French engines always beat the English in speed; and we have no doubt that the reason given at the time was the true reason. The English engines, regarded as vehicles, were too stiff for the French roads. Now, the American engine, built for bad railway tracks, with its spring rigging, compensating beams, bar frames, and loosely-fitting axle-boxes, works like a basket on the road, and runs with a freedom of which an accurately-made and fitted machine like a first-class English locomotive is quite incapable. It is the want of perception of this truth which has caused English engineers to draw up specifications which are thoroughly mischievous, and inspectors to condemn, in their ignorance, work that is essential to success. We can only repeat here what we have said over and over again, namely, that to construct colonial engines, or engines for such countries as South America, with the same rigidity of boxes and springs, the same paucity of provision for lateral and vertical motion, as distinguish English engines running on the best track in the world, is to court failure, and to entail on the unfortunate engineer who has to work with these locomotives an immense amount of worry, resulting at last in the alteration of details, and what is almost tantamount in some cases to a rebuilding of the engine.

We have never said that English locomotive builders cannot build engines quite as easy on a road as anything that American shops can turn out. Nay, more, if the builders were left to themselves, they could turn out better engines. But it is a matter quite notorious that the builders have to work to specifications, and that there are not drawn up with an intelligent perception of what is really wanted. These are facts that ought not to be forgotten. In this country, from a very early period great attention was paid to track. Brunel proposed that a car with two huge grindstones, caused to revolve by an engine, should be run over the road to remove every asperity and reduce the rails to a dead level surface. In the United States the early railways had a track of longitudinal timbers, on which were spiked flat bars of iron 2½ in. wide and ½ in. thick—the well-known "strap rail," in fact. The locomotives which ran over this permanent way were of necessity extremely flexible; and flexibility was obtained by the use of bogies, balance beams, and enormous side-play—things wholly unknown in this country. Such an engine as Gooch's North Star could not have run ten miles on a strap rail track. But American engines managed to do their 25 miles an hour on it without difficulty. The lessons thus learned by American locomotive designers have never since been forgotten. They have modified American practice ever since; and the result is that to this day the American engineer loves to impart a flexibility to his engines, which is regarded as an absolute defect by not a few influential engineers in this country. In a few words, experience is the foundation of all knowledge; and Americans have had for more experience—half a century of it at least—of bad roads than we in this country have had. It is not surprising that they should be able to teach us something in this connection, and, however unpleasant it may be to some persons to admit it, it is none the less certain that the English-built locomotive intended for service on a bad road will or will not be successful just in so far as it does or does not embody those principles of construction which our American rivals have deduced from a very extended and varied experience.

From various parts of the world statements reach us to the effect that the comparatively roughly-made American engine is a more satisfactory machine than its beautifully finished English or Scotch made brother. We see no reason why such statements should be made if they are not true. We have read specifications for engines, and we have made ourselves acquainted with the practice of inspectors, and bringing our own knowledge of the facts to bear, we are certain that the engines which result from the specifications and inspection are not the best adapted to the intended work. We do not wish to criticize individuals, and we find it hard to state cases by way of illustration, which will not seem to press hardly on this man or that; but we may say that we can call to mind one instance in which six-wheeled engines with rigid plate frames, and a comparatively long wheel base, were set to work against American engines of much rougher make with four wheels coupled and a bogie. The English engines burst the road, ran off it, and did such mischief that they were thrown on one side and the American engines did all the work. We can call to mind another case, in which two beautifully made engines, built to special design for the 5 ft. 3 inch gauge, played such havoc with a very bad road that they had to be practically rebuilt, the wheel base shortened, and the axle-boxes cut away to give side play, before they could be used. We have seen engines with the cylinders thrown so far forward to get a short wheel base that the engines literally jumped themselves off a bad road, and could not be used till they were fitted with pony trucks, which the designer would not have at any price. The highest excellence of material and the utmost beauty of workmanship will not compensate for such defects of design.

We need scarcely say that it affords us no particular pleasure to write thus. But, on the other hand, we have the best interest of the locomotive builders of this country at heart, and we should wholly fail in our duty if we said pleasant things, and maintained that the typical English locomotive must be best for Australia or South America, or China, or Africa, just because it is the best for the railways of the United Kingdom. We repeat that Americans more fully understand what is wanted for railway service in a new and cheap country than we do, and that we ought not to be too proud to learn from them. The locomotive-building firms in this country are by no means numerous; and we venture to say that they have nothing to learn from Americans or anyone else. But this is not true of other people in this country, and it is the other people who settle what the locomotive for distant lands shall be.

The cost of a modern office building in New York City is stated by Mr. R. P. Bolton, in a paper before the American Society of Mechanical Engineers, to be from 36 to 40 cents per cubic foot of its gross volume, outside measurement. The excessively high and very highly ornamented buildings cost more. The total cost of mechanical appliances in a 16-story building, with basement and sub-basement, having about 6,000 square feet of renting area per floor, was \$82,000.

WESTINGHOUSE BRAKES IN RUSSIA.

It was announced in our columns some time ago that the Westinghouse Air Brake Company had made arrangements to manufacture brake apparatus in Russia. The works are now completed and running, and with the receipt of this news comes an announcement that the company has just closed a contract with the Russian Imperial Railway Commission to equip all of its cars during the next four years with Westinghouse brakes. The contract was awarded as a result of tests made by the commission, and it covers the equipment of both freight and passenger stock. Statistics whereby the exact mileage and amount of rolling stock to which this contract applies are not available, but it is safe to say that it includes about 24,000 miles of government roads aside from about 8,000 miles of private roads which are likely to be equipped with this apparatus.

BOILER STEEL WORKED AT TOO LOW TEMPERATURES.

The danger of working boiler steel at "blue heat," or at temperatures of from 700 down to 550 degrees F., is well known, but in spite of this the practice is often seen and it will probably continue to be common until the general introduction of flanging presses is accomplished. Prof. H. Wade Hibbard brought the subject before the New York Railroad Club in a paper recently read, and in the discussion it became clear that the use of the flanging press is one of the greatest of recent improvements in locomotive boiler making.

Blue working without annealing is forbidden on work for the United States Navy, as was stated by Mr. L. R. Pomeroy, who also presented records of the Board of Trade tests at the Steel Works of Scotland, where 48 plates were tested by coupons cut from each, half of which were bent cold to an angle of 180 degrees around a bar of a diameter of twice the thickness of the strips. Corresponding strips were heated in boiling tallow and bent at this temperature, whereupon every one cracked before reaching 180 degrees. A plate heated and cooled was stated to be no worse for the operation, but if, while cooling, the steel is worked at the blue heat, it will be found to be seriously injured in quality.

Mr. Pomeroy said that Mr. Stromeier, in 1896, was among the first to call attention to the injurious effects of working steel at blue heat. The most interesting results were obtained by bending tests. The test strips were bent alternately in opposite directions till they broke. The strips were each clamped between a steam hammer and its anvil, and the projecting end was bent down by hammering (over a mold with round angle) through an angle of 45 degrees. The test strip was then turned over and bent in the opposite direction. Briefly, it was found that while a test strip bent cold would stand twenty to twenty-six bendings before cracking, if it was once bent while at the blue heat and allowed to cool, it broke afterwards with very few bendings.

SUMMARY OF TESTS BY C. E. STROMEIER.

Conditions to which the Strip had been Brought.	Average No. of Bendings Before Cracking.		
	Medium-hard Steel. % inch.	Mild Steel. % inch.	Very Mild Steel. % inch.
Unprepared or annealed.....	21	12½	26
Bendings while at blue heat.....	2½	1½	2½
Bent at blue heat once and cooled.....	3	2½	11
Bent at blue heat twice and cooled.....	½	1½	¾
Bent once cold.....	20	9½	...
Bent twice cold.....	19½	8½	19
Bent four times cold.....	...	...	13
Bent eight times cold.....	...	...	15

Tests by Mr. F. W. Webb of the London & North Western Railway were also quoted in support of the same principle.

A common test used by boilermakers abroad is to cease work as soon as a plate which has been red hot becomes so cool that the mark produced by rubbing a hammer handle or other piece of wood over it will not glow. A plate which is not hot enough to produce this effect, yet too hot to be touched by hand, is probably blue hot, and should, under no circumstances, be hammered or bent.

Mr. H. D. Gordon, formerly Master Mechanic of the Pennsylvania at Juanita, gave his opinion very clearly on the danger of working at blue heat, and strongly favored the use of forging presses. What he says about the press is particularly important.

"Notwithstanding all that has been said and written on this subject, I believe it is one that is not generally well enough understood by boiler shop foremen and those having to do with the flanging of sheets. Hand flanging at best is a slow and laborious operation, especially when the heats are taken in the usual method and with an open fire. A small portion only of the sheet can be heated at one time, and the tendency is with the man managing the work to try to get as much of the sheet flanged at each heat as possible. Consequently it is often hammered at a much lower heat than it should be and with undoubtedly injurious effects to the sheet. Many of our mysterious cracks that are found in the flanges of boilers are

no doubt due to this cause. The ideal way, undoubtedly, for flanging a sheet is by the use of hydraulic flanging presses. It is now about ten years since the Pennsylvania Railroad erected their new shops at Altoona for building locomotives, and at that time they put in a hydraulic press and complete plant for the flanging of boiler sheets by power at one operation, or, at most, two for each sheet, and as I had charge of the installation and operation of that plant, I had a chance to learn considerable about this method of flanging, and am convinced that it is the only proper way and should be more generally introduced. At the time the machinery was purchased there had not been a great deal of that kind of work done in this country, especially in locomotive boiler shops, and it was a difficult matter to get information as to what was required. We were obliged to depend largely upon the manufacturers of the press, which, by the way, was made in England. A very fine furnace was designed, which proved to be a complete success, and that is a very necessary auxiliary to a good flanging machine. That particular press did good work, and is still doing it, and I am sure that any master mechanic or those having to do with a boiler shop who once handled sheets flanged by that method would never want to go back to the old way of flanging by hand. Of course it is not possible for small roads with a limited number of engines to consider the installing of such a complete plant, but it is a question whether the large systems with a great number of engines and boilers could not profitably take up this matter with a view of installing at least one complete plant. There are machines made called sectional flangers which do not require such a large outlay for dies and which are a very great improvement on the method of flanging by hand. A combination of both will sometimes enable a very difficult sheet to be flanged in a very satisfactory manner. I think that every shop of any importance should at least have a large furnace in which the sheets can be thoroughly heated all over and annealed, and which would no doubt remove some of the bad effects due to improper working at low heats by the hand method. It was not long after the installation of that plant before the largest locomotive works in the country followed by introducing flanging presses, and they were generally much heavier and larger, and I think that it is quite common practice with them now to flange at least all of the plain sheets of their boilers."

Mr. T. R. Browne, Master Mechanic, Pennsylvania, who is now in charge of the Juniata shops, contributed the following to the same discussion:

The high grade and peculiar character of firebox steel necessitates more or less peculiar handling to produce the best results, and it is a pretty well recognized fact that to attempt to work this steel for the purpose of scarfing at a heat too low is to encourage cracks and a change of its structure, which will make it entirely too brittle either for safety or for long service. A low, red heat, and the work of scarfing completed while this heat lasts, or at least before it reaches a blue point, is generally the safest. I have known of cases where the location of the anvil at a point where a severe draft, incidental to adjoining doors or openings in the shop, had been the direct cause of cracking of sheets which were being scarfed over this anvil; and that, with pieces cut from the same sheet which had been spoiled, due to the cause stated, a test made at other points in the shop where there was an absence of these drafts, there was no difficulty whatever in securing the very best results.

As to the question of flanging by machine, as compared with the hand process, the advantages are almost too obvious to need comment. The question of great reduction in cost and absolute interchangeability of the parts, the even and thoroughly distributed stress on the material, as compared with the very best results of hand flanging, place this method far in advance of any other known at this time. All of the sheets, however, should be thoroughly annealed, and it is generally sufficient to allow them to cool with the last bent of flanging to secure an amount of annealing which will thoroughly remove all serious internal stress.

FRICTION LOSSES OF LOCOMOTIVES.

The friction losses of locomotives have been investigated by Prof. Goss by aid of the laboratory locomotive at Purdue University, and the records are to be found in an article by him in the Purdue University "Exponent." The friction losses were found to be variable on account of changes in cut-off and speed. The highest value of the loss by friction in proportion to the indicated horse-power of the engine was 23.3 per cent., corresponding to a speed of 55 miles per hour at 6-inch cut-off. The lowest value was 5.5 per cent, and was obtained at a speed of 25 miles per hour and at 10-inch cut-off. The friction loss decreases with an increase in cut-off. That is, for the development of a given amount of power, the more uniform the effort on the cranks the smaller the friction. This fact was confirmed by a test at 15 miles per hour, cut-off 20 inches, initial pressure in the cylinder 81 pounds, in which the loss in draw-bar pull was only 142 pounds. Within the limits of the experiments the loss does not change with the boiler pressure. For any cut-off the horse-power absorbed by engine friction is directly proportional to the speed. For any cut-off the higher the speed the greater the proportion of power absorbed by engine friction. This is due to the fact that the horse-power absorbed by friction is, and the indicated horse-power is not directly proportional to the speed. Prof. Goss says: "In the light of the data it would seem that under usual working conditions there is a loss in draw-bar pull, due to engine friction, of about 500 pounds. With the locomotive running at 50 miles per hour this corresponds to 67 horse-power."

SUGGESTIONS FOR RUNNING VAUCLAIN COMPOUND LOCOMOTIVES.

While the proper use of the starting valve of a Vauclean compound locomotive is simple and easily understood, we have noticed, on several roads, a tendency to neglect this important part of their management. In our December, 1898, issue, page 403, we illustrated a device designed and constructed by the mechanical department of the Philadelphia & Reading Ry. for the purpose of preventing the practice of leaving the starting valve open, except when it was necessary in starting or in pulling over a summit. The following is taken from a little book entitled "Locomotive Data," recently issued by the Baldwin Locomotive Works, and in addition to outlining the proper method of starting a train, the suggestion as to the use of the starting valve in drifting should have attention from all who are using these engines:

In starting the locomotive with a train, place the reverse-lever in full forward position, throw the cylinder-cock lever forward, which operation opens the starting valve, and allows live steam to pass to the low pressure cylinder. The throttle is then opened, and as soon as possible when the cylinders are free of water and the train is under good headway, the cylinder-cocks and starting valve should be closed. As the economy of a compound locomotive depends largely on its greater range of expansion, the engineer should bear in mind that in order to get the best results he must use his reverse-lever. After the starting valve is closed and as the speed of the train increases, the reverse lever should be hooked back a few notches at a time until the full power of the locomotive is developed. If after moving the reverse lever to the last notch, which cuts off the steam at about half-stroke in the high-pressure cylinder, it is found that the locomotive develops more power than is required, the throttle must be partially closed and the flow of steam to the cylinder reduced. In slightly descending grades the steam may be throttled very close, allowing just enough in the cylinders to keep the air valves closed.

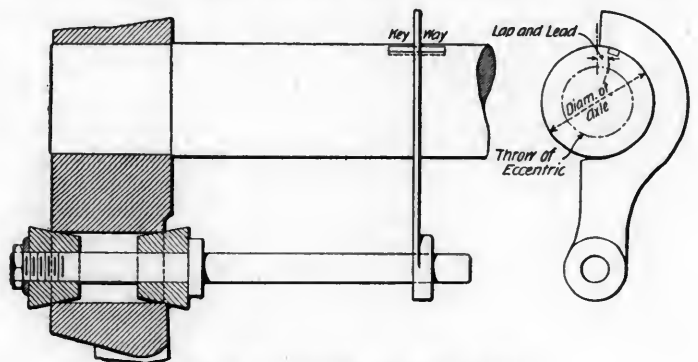
If the descent is such as to prevent the use of steam, close the throttle and move the reverse lever gradually to the forward notch and move the starting valve lever to its full backward position. This allows the air to circulate either way through the starting valve from one side of the piston to the

other, relieves the vacuum and prevents the oil from being blown out of the cylinder. On ascending grades with heavy loads, as the speed decreases the reverse lever should be moved forward sufficiently to keep up the required speed. If, after the reverse lever is placed in the full forward notch, the speed still decreases and there is danger of stalling, the starting valve may be used, admitting steam to the low-pressure cylinders. This should be done only in case of emergency, and the valve closed as soon as the difficulty is overcome.

DEVICE FOR LAYING OFF ECCENTRIC KEY-WAYS ON AXLES.

Baltimore & Ohio Railroad.

The simple and convenient device illustrated by the accompanying engraving is used on the Baltimore & Ohio for laying out the key-ways on driving axles, whereby the eccentrics are secured in position before the wheels are placed in position under the engine. The drawing makes the method of operation



Device for Laying Off Key Ways.

clear with very little description. The spindle which carries the two conical plugs is self centering in the crank pin hole in the driving wheel, and on the end of this spindle is an arm which partially encircles the axle. From this the key-ways are laid off with the proper angular advance. This device has been used for several years with very satisfactory results.

THE BUHOUP THREE STEM COUPLER.

The Buhoup Three Stem Coupler, manufactured by the McConway & Torley Co., was put through a series of severe tests at the recent convention at Old Point Comfort, in order to try its operation in taking severe curves. The results are given in the "Railway Age." The couplers were fitted to a Union Pacific pressed steel car of 90,000 pounds capacity and a P., C., & St. L. coal car of 80,000 pounds. They were tried on two curves, one said to be 58 and the other 76 degrees, and the cars were coupled and uncoupled easily on them. The strong claims made for this coupler and method of attachment are based upon the flexibility of the whole arrangement, whereby the natural movements of the couplers in taking curves may be accommodated without placing the cars or the couplers under unnecessary stress. The coupler head being attached to the coupler by a swivel joint, is able to yield to lateral movements, and in addition to this, the three stem arrangement with the three coupler springs permits of increasing the spring resistance of the coupler to prevent the springs from being closed up solid in hauling heavy loads. The three stems are not at all likely to break at once, no matter what the stress, and herein is a safeguard against the form of accident due to the falling of broken couplers on the track. These couplers have been in use for four years and the experience gained has shown the desirability of urging their use on freight equipment also.

Twenty consolidation locomotives, with Wootten boilers and 21 by 28-inch cylinders, have been ordered by the Erie from the Brooks Locomotive Works.

EXTENDED PISTON RODS.

"What advantages are gained by the use of piston rods extended through the front cylinder head?" was one of the topical discussions at the Master Mechanics' Convention, and the following is taken from the discussion:

Mr. R. H. Soule of the Baldwin Locomotive Works opened the discussion as follows:

"This question of the benefits, if any, following the introduction of extended piston rods or tail rods, is one of those questions which is now coming to the front as one of the natural sequences of the great increase in the size of our locomotives. There is little fixed opinion on the subject, among the railroad men, and no unanimity of opinion among the locomotive builders. I know of one road, the New York Central, which makes it a rule that all cylinders, 19 inches and upwards in diameter, shall have the piston rods carried through the front ends. I heard from a locomotive builder who does not consider it necessary to supply the piston rod extension unless the cylinder is 28 inches in diameter or upwards; there is a wide difference of opinion on this subject. As regards the mechanism by which the piston rod extension shall be supported in cases where it passes through the front end, there is no settled practice. It seems to be difficult to get a bushing or support more than 5 inches in length if you insist on having the piston rod extension in the bushing at all times. If you are willing to have the piston rod extension draw nearly out of the bushing on the back stroke, you can increase the bushing to 9 inches. When these extensions were first introduced into service they did not carry a good service record, because in the early cases they were not lubricated. The question of lubrication comes up, and one locomotive builder states it to be the practice where the extension is applied to always apply a triple sight-feed lubricator. One sight-feed lubricator being devoted to the usual purposes and the two branches of the third going to the bushing or front end cylinders for the lubrication of the piston rod extension. Another locomotive builder states this to be unnecessary, and that the successful lubrication of this piston rod extension only requires some nice work in the arrangement of lubricating grooves in the bushing, so that the steam which is supposed to be supplied with its own lubricant can reach the bearings in question. Among the locomotive builders it is felt that the piston rod extension in some approved form, when the practice has reached a final stage, where it commends itself to the railroads, will be a necessary feature in all future powerful locomotives; but there are a number of details to be worked out, and I do not think it can be said yet that any device which has been put out is an absolute success. One of the legitimate questions in connection with this problem of extended piston rods is whether the increased clearance which necessarily follows its use is not detrimental to the economy of the engine. We will take it for granted that extension piston rods are operated in closed tubes or pockets attached to the cylinder head, although it is entirely possible to make an arrangement by which the extension rod shall pass through a stuffing box; but under the present conditions the usual practice is to use the pockets for the rod to work in, and that necessarily increases the clearance at the front end of the cylinder. I have no information on that point, but it is a legitimate question whether that increased clearance would not impair the efficiency of the locomotive."

Mr. T. R. Browne, Master Mechanic, Pennsylvania Railroad, stated that he did not think it necessary to have the extended rod on an ordinary cylinder. Continuing, he said:

"We had an engine with 24-inch cylinders, solid heads, with a lining of block tin around the head. After a while they wore away and the crosshead began to show trouble. The crosshead also had block tin on top and bottom of the wearing surfaces, between the guides and the front end of the crosshead, and it would wear on the bottom of the back and on the top of the front end; and whenever you went by the engine, after she was running a little while, it looked as if the guides were out

of line. The piston wore at the bottom and the crosshead went down with it. We took the crosshead out occasionally and relined it and put it in again in good condition, and we turned the piston around to let it wear on the other side, but the same trouble would take place. Finally, we decided to put an extension rod on, and after we did so there was no further trouble. We demonstrated on the 24-inch piston that the extended rod was a benefit."

Mr. A. L. Humphrey (Colorado Midland)—"So far as the question of extended piston rods on engines that drift a great deal is concerned, I think that is beyond experiment. As it applies to our road I know that with large engines with 20 and 21-inch cylinders, where they drift at times 100 miles at a stretch, it is necessary to have the extended rods in order to keep the cylinders from wearing. I am inclined to think that the stuffing box principle is a good one. We are not troubled with the question of lubrication. Our engines have 180 pounds pressure and we simply use the lubrication from the cylinder, nothing else, and we have experienced no trouble, except, of course, to turn the bushings often enough to keep them as nearly central as possible. We turn the bushings every 60 days."

Mr. C. H. Quereau, Master Mechanic of the Denver & Rio Grande, said:

"The road with which I am connected has a number of locomotives with the extended piston rods, but it is true that our engines are drifting half the time. We now have in service a design in which the bearing is $8\frac{1}{2}$ inches, and adjusted perpendicularly, so that as the piston rod wears, we can raise the piston to the center of the cylinder. I think that the best device along this line is in use on the Atchison, Topeka & Santa Fe road, in which they have a long bearing similar to the one I have just mentioned, and just ahead of that they have a packing gland. One difficulty with ours, which is simply a brass bearing, and a sleeve over the extension piston rod, is in the matter of lubrication. We have on most of the engines a lubricating cup, a cup in which the oil is placed the same as on the lubricator itself, except that there is no sight feed. It will hold possibly a quarter of a pint; and we find the first time the locomotive throttle is closed the oil is drained out of this lubricator cup. With the device used by the Santa Fe road they have a perfect means of lubrication as much as you have on the piston rods at the back ends of the piston."

Mr. J. E. Sague, Mechanical Engineer of the Schenectady Locomotive Works, contributed the following:

"Our first effort was with a brass bushing 5 inches in length. That did not seem to be enough, and the wear of the bushing was excessive. We now extend the length of the bushing to 9 or 10 inches. We put an auxiliary sight feed in the cup where the extended piston rod is used. We do not feel by any means that it is an absolute necessity, from the fact that we build more engines with extended piston rods in which the auxiliary lubricator is not used than in which it is used. It may be of advantage where the engines do a great deal of drifting. We apply the extended piston rods to all compound locomotives, and I am now applying the auxiliary lubricator to such engines as do a great deal of drifting. Our experience has been most satisfactory with extended piston rods."

The elements of safe operation of fast trains on a single track road were admirably summed up before the St. Louis Railway Club recently, by Mr. W. A. Garrett, Division Superintendent of the Wabash Railroad, in the following terse language, which applies equally well to roads with more than a single track: "Requirements—Good road bed and bridges; reliable motive power and equipment; officials with loyal support; sober, capable, intelligent, quick-thinking and emergency-acting employees in all departments, thoroughly organized, interested in performance of duty and disciplined from the following recipe, which I can recommend fully: 'One-half kindness, the other half firmness.'"

COLOR-WEAKNESS AND COLOR-BLINDNESS.

It is important that tests for color-blindness for railroad men should establish beyond question the ability to distinguish colors, not only when atmospheric conditions are favorable, but when they are unfavorable. It is also important that the tests should be fair to the candidates. These considerations entitle the investigations of Prof. E. W. Scripture of Yale University, on this subject, to the careful attention of railroad officers. He presents his views in a contribution to "Science" as follows:

It is generally accepted as a well established fact that the traveling public is fully protected by the present tests for color-blindness to which railway employees and pilots are subjected. Yet several of the mysterious accidents that have occurred during the last two years might be explained on the supposition of color-blindness on the part of responsible lookouts. In fact, I believe myself in position to prove that persons of dangerously defective color-vision actually do pass the regular tests and obtain positions where their defects are continual dangers to public welfare. In the first place, I have at the present time among my students one who is absolutely perfect at the wool-test. He can match wools with incredible precision at any distance away; he is, nevertheless, color-blind. This case is typical of a class of persons with eyes abnormally acute for differences in color, but yet with only two fundamental sensations instead of three.

In the second place, I have had among my students those who possessed perfect color-vision for near objects or bright objects, but who were practically color-blind for weakly illuminated or distant objects. These persons possess the typical three fundamental color sensations, but have one of them weaker than the normal. A person of this kind may pass the wool-test with the utmost perfection if the test is performed close by, but will fail if the wools are removed to a distance of 20 or 30 feet. This peculiar defect I take the liberty of terming "color-weakness." The first student of this kind that I examined passed the wool-test close at hand and yet was unable to distinguish red and green lanterns a few hundred yards away. Cases similar to this have been reported by the British Marine Examiner, Eldridge-Green. Among other cases he quotes a letter from an engineer containing the following statement: "I have been on the railway for thirty years and I can tell you the card-tests and wool-tests are not a bit of good. Why, sir, I had a mate that passed them all, but we had to pitch into another train over it. He couldn't tell a red from a green light at night in a bit of a fog."

To eliminate both these classes of persons we must have a method of testing on quite different principles from the usual ones. In the first place, the sorting of delicate shades of colors, according to likeness, must be replaced by naming certain fundamental and familiar colors. The sorting of wools is a quite unusual task and perplexing task to a man brought up in a railway yard and on shipboard. It puts a nervous man at quite a disadvantage; it furnishes the unsuccessful candidate with the excuse that the judgment required was so unlike any he had made before that he failed from nervousness; and, finally, it is not a guarantee that all who pass are not color-blind. The naming of colors should—as Donders proposed—be rigidly required. The engineer or the pilot in his daily routine is not called upon to match colors, but to decide whether a light is red, green or white; he should be tested on just this point. The color-blind student referred to above who can pass the wool-test to perfection, fails at once when called upon to name the wools. The naming of delicate and perhaps unusual shades should, however, not be required; the colors to be named should be the three familiar ones: red, green and white, so manipulated that every possible chance for confusion is presented.

The second necessity for eliminating danger is that of an absolutely certain test which shall detect both the color-blind and the color-weak. Acting on the basis of suggestions from the work of Donders and of Eldridge-Green, I have devised a test that meets this requirement as well as the first one.

The instrument may be termed the "color-sight tester," or the "color-sight tester." In general appearance it resembles an ophthalmoscope. On the side toward the person tested, Fig. 1, there are three windows of glass, numbered 1, 2 and 3, respectively.

The opposite side of the tester, Fig. 2, consists of a movable disk carrying twelve glasses of different colors. As this disk is turned by the finger of the operator the various colors appear behind the three windows. At each movement of the disk the subject calls off the colors seen at the windows. The windows, 1, 2 and 3, are, however, fitted with gray glasses. No. 1 carries a very dark smoked glass; all colors seen through it will be dark. No. 2 carries a piece of ground glass, showing all colors in full brightness. No. 3 carries a light smoked glass. There are thus thirty-six possible combinations of the colors. The twelve glasses are, however, mainly reds, greens and grays.

A suitable arrangement of the colors gives direct simultaneous comparisons of reds, greens and grays of different shades. The well-known confusion by color-blind persons of dark greens with reds, greens with gray, etc., are exactly imitated, and the instrument gives a decisive test for color-blindness. Its peculiar advantage, however, lies in the fact that it presents reds, greens and grays simultaneously in a large number of different shades of intensity. The light of a green lantern, at different distances or in a fog, is simulated by the green behind the different grays; at the same time a white light is also changed. The color-weak



Fig. 1.



Fig. 2.

person to whom weak green is the same as gray (white at a distance) is utterly confused and thinks that the weakened green is gray (white) and the dark gray is green.

The actual test is performed in the following manner: The tester is held toward a window, at about 2½ feet from the person tested. The operator begins with any chance position of the glasses, and asks the person tested to tell the colors seen through the three glasses, Nos. 1, 2 and 3. He answers, for example: "No. 1 is dark red; No. 2 is gray; No. 3 is green." The operator records from the back of the tester the letters indicating what glasses were actually used. If he finds that A, D and G were opposite the glasses Nos. 1, 2 and 3 he records: A 1, dark red; D 2, gray; G 3, green. The disk is then turned to some other position; the colors are again named, and the operator records the names used. For example, the result might be: "No. 1 is dark green; No. 2 is white; No. 3 is red;" and the record would read: G 1, dark green; J 2, white; A 3, red. Still another record might give: J 1, dark gray; A 2, red; D 3, medium gray. Similar records are made for all combinations. Of course, the person tested knows nothing concerning the records made. A comparison with a list of the true colors for each position determines whether the test has been passed or not.

The three records just cited were all obtained from the red

glass, A; the gray glass, D; the green glass, G, and the ground glass, J, in combination with dark gray, No. 1; the ground glass, No. 2, and the medium gray, No. 3. Those familiar with color-blindness will notice that these combinations place side by side the colors most confused.

The records can be taken by anyone, and, on the supposition that the record has been honestly obtained and that the instrument has not been tampered with after leaving the central office, the comparison is mechanical. There is none of the skillful manipulation required in the wool-test and none of the uncertainty attaching to its results. The only instruction given to the subject is: "Name the colors;" the results render the decision with mechanical certainty.

One of the testers is in use on one of the English railways, another on the central division of the New York Central Railroad. From the former I have not yet heard, but the examiner on the latter reports that since using the tester he has found men who get through the wool-test, but are caught by the tester. On the other hand, he states that "the men examined say that this test is more like the signals they are used to seeing every day on the road, and is, therefore, fairer than to ask them to pick out a lot of delicately tinted pieces of yarn."

An experience of several years seems to justify the following claims for the color-sense tester:

1. It detects with unerring precision both the color-blind and the color-weak.
2. It is a perfectly fair test for the men concerned and injures no man by requiring an unfamiliar judgment.
3. It requires but a very small fraction of the time used on the wool-test.
4. Its decisions are self-evident and unquestionable.

THE AUTOMATIC ELECTRIC FEED WATER PURIFIER.

This is an interesting and apparently very successful type of feed water purifier, which adds no complication to the working parts of a steam plant and simply forms a part of the feed pipe between the pump or the injector and the boiler. Mr. Samuel M. Green, Mechanical Engineer of the American Thread Company, in discussing the paper by Mr. Howard Stillman, Engineer of Tests of the Southern Pacific Railway, on "A Water Purifying Plant," before the American Society of Mechanical Engineers (Proc. A. S. M. E., Vol. XIX, page 437), spoke as follows:

"In a battery of Manning boilers of about 600 horse-power at the mills of the Merrick Thread Company, Holyoke, Mass., we have had a great deal of trouble from scale forming upon the tubes, and then dropping down upon the crown sheet. Many kinds of scale solvent have been tried, including soda ash, kerosine and crude oil, but it has been found almost impossible to keep the tubes from leaking. About three years ago (this was said in December, 1897) an electro purifier was brought to my attention. It consisted of a series of copper and zinc plates placed in an upright pipe. The feed water is passed up through this pipe and comes in contact with the zinc and copper plates. It was found necessary to keep the temperature at above 170 degrees. When putting in this purifier I did so with a great deal of misgiving, but it has since proved itself reliable. I do not think that its action upon the scale forming properties in the water has been explained, but the fact remains that our boilers have been free from scale since its installation. The scale, instead of forming hard upon the boiler surfaces, is deposited in the shape of mud, which is blown out every day. The zinc plates are renewed once a year, at a cost of about 10 cents per horse-power. I have put this purifier upon several plants, in one case particularly where the water was from an artesian well. In this plant as soon as the purifier ceases to act the boiler immediately becomes coated with scale. As long as the zinc plates are active the boiler is kept clean."

Prof. R. H. Thurston, in the same discussion, offered the following in explanation of the operation of these devices:

"It seems, for some reason which I do not quite understand, to prevent the sulphate of lime coming down in the form of hard scale. It is still sulphate of lime, but it does not cover

the heating surface with incrustation; it is not hard as marble, or harder, as is often the ordinary scale, and it is easily washed out."

The probable explanation of its operation is that the presence of the electric current generated by this device in the presence of the warm feed water prevents the crystallization of the scale and thus robs it of its power to become firmly attached to the heating surfaces. It does not prevent the precipitation, but changes the character of the precipitate so that it does not adhere to the tubes and sheets. It does not appear to act in the same way with all feed waters, but with the waters to which it is adaptable it works well. In a recent letter to us Mr. Green says that in most cases he has had very satisfactory results.

This purifier is manufactured by the Curtis-Hull Manufacturing Company, 42 Union Place, Hartford, Conn. It seems to be particularly well adapted to use on locomotives, and as its application involves no undesirable complication, it is hoped that trials will be made with it in that service.

LONG LOCOMOTIVE RUNS.

Baltimore & Ohio Railroad.

The experiment of almost doubling the runs of the passenger engines of the Baltimore & Ohio has proved more successful than its warmest advocate had any idea that it would. For a great many years the average run on the Baltimore & Ohio was 125 and 150 miles, and it was supposed that on account of the heavy grades one locomotive could not be used for a continuous run of 200 or 225 miles. However, General Manager Underwood and Mr. Harvey Middleton, Mechanical Superintendent, determined to make the experiment, and during the past three months have demonstrated that these continuous runs are not only successful but economical, even on the Baltimore & Ohio, where 1, 2 and 2½ per cent. grades are found. Passenger engines are now run continuously from Cumberland to Parkersburg, a distance of 207 miles, and from Cumberland to Wheeling, 201 miles. From Cumberland to Parkersburg the engines go out on trains 1, 3 and 55, returning on trains 2, 4 and 12. From Cumberland to Benwood the run is 200 miles, and the engines go out on train 7, returning on train 46. This change has enabled the road to reduce the number of engines in that service from 24 to 12, and has doubled the mileage of each engine when run from Philadelphia to Washington, Washington to Cumberland and from Cumberland to the Ohio River. Each locomotive will average very nearly 7,500 miles per month.

West of the Ohio River three engines are used to haul trains 7, 8, 46 and 47 between Benwood and Chicago Junction, a distance of 190 miles, and they will average about 7,680 miles a month. These engines are double crewed. Four engines at present are running trains 103, 104, 105 and 106 between Benwood and Cincinnati, a distance of 254 miles, running through westbound and are relieved at Newark eastbound. These engines are also double crewed and they will average a monthly mileage of 7,650 miles. Trains 3 and 4, between Newark and Sandusky, and local passenger trains between Newark and Shawnee are run by two engines and three enginemen, the distance being 159 miles. These engines will make an average mileage of about 5,742 miles per month. Trains 16, 17, 114 and 115, running between Columbus and Sandusky, a distance of about 149 miles, are run by one engine, double crewed, with a monthly mileage of about 8,012 miles. Trains 101, 102, 107, 108, 111 and 112, between Cambridge and Cincinnati, a distance of 201 miles, are handled by three engines and five enginemen, with a monthly average mileage per engine of 6,443 miles. It is estimated that under the new method the enginemen make about the same wages with less work. They average about 3,800 miles per month each, and under the system west of the Ohio River the saving is equally as great as has been east of the river, as it now takes 13 locomotives to handle the trains, while formerly 25 were required, it being a net decrease of 12 locomotives.

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Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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In this issue some reasons are given why condensers should be applied to stationary engines in railroad and other shops. They may be used so easily, and when once installed give so little trouble that when once considered as a necessary part of a steam plant they will come into such general use as to make an exhaust pipe discharging steam an unusual and noteworthy matter. Many motive power men and engineers spare no effort to prevent a few pounds of steam from being wasted at pop valves and are not stirred at all by the loss of tons of it through exhaust pipes. This is just as wasteful in principle and more worthy of attention. The advantages of condensers are probably appreciated, but the fact that any one may use them is not generally understood. Any one may put in a cooling tower and thereby use the condensing water over and over again. Some people have not thought of using them, because exhaust steam is required for heating. There are very few cases where the cost of condensers and cooling towers will not be saved in a year or probably two years, and it is seldom that all of the exhaust is needed for heating. A large proportion of the time none is needed, and the full

advantages of the condenser will be available at least three-quarters of the time, even in comparatively cold climates. Where coal costs two and three dollars a ton there is no question of the profit to be had by condensers, and it will pay to put them in where the price is much lower than that. The cost of the apparatus is low, the return large and immediate and the idea is simple. Many shop engines are being loaded more and more every year until they are overloaded. This is a good way to make the old engine answer the purpose a little longer. We wish space permitted the reproduction of a paper read some time ago before the American Society of Mechanical Engineers by Mr. J. H. Vall, which gives an account of the installation of a condenser and cooling tower. In this case the capacity of the plant of 28 boilers 48 inches in diameter and 20 feet long was increased by 1,000 horse-power without changing the plant or adding boilers or engines.

The "few well tried forms" of locomotives made in this country, and mentioned elsewhere in this issue in a communication from Consul Monaghan, seem to be the basis for a vast deal of misunderstanding abroad, but foreigners who want locomotives at relatively low prices and quick deliveries are looking in this direction as they never have before. Everyone who understands locomotive building in this country knows that our builders do not "always build from a few sets of patterns, castings for which are always carried in stock." It does no harm, however, for foreigners to believe that this is done, so long as they know that they may obtain good locomotives here on short notice. It is this feature of American locomotive building practice that ought to be most vigorously taught abroad at this time, namely: That we build good locomotives and build them rapidly; further than this, they may be exactly duplicated on subsequent orders. We cannot hope to compete with German builders for their home trade because of the willingness in that country to use excessive complication, but we probably shall be able to fill many of the orders now received by the German builders for other countries where our simplicity of construction will count favorably. American builders are probably not blind to the situation described by Consul Monaghan, and the present opportunity is one which they will not neglect. A long story concerning locomotive practice is told in the statement that 18 German locomotive building shops can turn out but 1,400 locomotives per year. Opinions of our locomotive practice are changing in England, as may be seen by the quotations presented elsewhere in this issue from an editorial in "The Engineer," of London.

The importance of the working of boiler sheets in flanging at temperatures above the "blue heat" does not appear to be generally appreciated, although it has been known for years that steel worked too cold receives permanent injury which is likely to cause it to fail under stresses that are far below its normal strength. This was one of many valuable points brought up for discussion by Professor Hibbard's paper on locomotive boilers, recently read before the New York Railroad Club, and it will pay those who make or repair boilers of any type to examine their practice in this regard. Flanging is a difficult operation, especially when performed by hand without the aid of special formers. The work is naturally slow and the tendency to use as few heats as possible is strong. The result of this is to work the sheets as long as possible after each heat and frequently the temperature falls until the metal receives permanent injury, even before it has been put in place in the boiler. The ideal method of forming and flanging boiler plates is to use large furnaces, heating the entire sheet at once and then, by the use of hydraulic presses and dies to press the sheet into the desired form at a single operation. This, of course, requires a large outlay for special machinery and dies, which small establishments can not afford. The smaller sectional hydraulic flanging presses are available, however, and large dies are not needed with these. The work is not as rapid as with the large presses

and the danger of working at the blue heat is greater. A satisfactory rule for judging of the temperature below which the work should not be done is to rub a piece of wood over the surface of the plate, and if it does not leave a red glowing path the sheet is too cold and the work should stop. The necessity for increased care in this connection is more apparent with the increase in steam pressures, and by insisting upon this simple rule in the boiler shop a great deal of anxiety may be avoided. The "blue heat" occurs between temperatures of 550 and 700 degrees and is below the temperature at which iron will show a red glow in the dark. Its most prominent effect seems to be to reduce the ability of steel to resist repeated bendings and the life of modern locomotive boilers depends very largely upon this quality. A sheet which has undergone this treatment will withstand only about one-third as many bendings as before.

The remarkable progress which gas and gasoline engines are making is a natural result of education in regard to their advantages. The best of steam engines used for ordinary work consume about 2 pounds of coal per horse-power hour and from 6 to 12 pounds more nearly represents common practice with small steam engines. The cost of attendance for a steam plant is very high and proportionately higher per horse-power as the size of the engine decreases. A steam boiler requires constant nursing, frequent cleaning, scaling and overhauling, and also these expenses are constant, even if the engine is used but a few hours each day. The internal combustion engine presents an agreeable contrast to all this. It starts easily and quickly, and when once started it needs only to be oiled and properly loaded to work along unattended all day long. The fuel consumption is proportional to the load, and when the engine stops all expense stops also. As to the relative cost of operation, it may be confidently accepted that a gasoline engine will cost not more than half as much to run as a steam engine of equal power. The time has come for the gas engine to receive careful consideration by all who contemplate enlarging or remodeling old shops, and especially by those who are planning new ones. The new Westinghouse works for the manufacture of air brakes in Russia are to be driven entirely by gas engines. Why should they not be used for driving the machinery of railroad shops? They offer a most satisfactory method of distributing power and there are many designs that are quite ready for important responsibilities.

Piston valves are regarded by many as the coming valves for locomotives. The advantages they offer are the possibility of perfect balancing and shorter as well as more direct steam ports with reduction of clearance. The port openings of piston valves may also be much larger than those of flat valves for the same valve travel. Some of the best arguments in favor of this type of valves were offered in connection with the records of the performance of the Atlantic City locomotive of the Philadelphia & Reading Railway by Mr. Vauclain, and this is regarded as the strongest support that the piston valve has had. That valves of the piston type are not necessarily perfectly balanced merely because they belong to that type is conclusively shown by Mr. F. M. Whyte, on page 199 of our June issue. Mr. Whyte's table of the pressures of the packing rings against the casings is evidence enough that the form and size of the rings are exceedingly important. We know of one case in which the width of the rings in locomotive valves of this type were at first about $\frac{1}{2}$ -inch and having been gradually reduced to about $\frac{1}{8}$ -inch and then, owing to the rapid wear of the rings, they were discarded altogether and the valves were made in the form of plain cast-iron plugs without rings. In this a leaf has been taken from steam pump practice and it is said that the results are quite satisfactory. In using plug valves it will be necessary to provide for equal expansion of the valve and the casing and it will also be necessary to guard against the possibility of drawing smoke and cinders into the steam chests from the smoke box. Of this we shall have more to say at another time.

Professor Scripture's tests for color-blindness and what he terms "color-weakness," as described on another page of this issue, appear to be logical and altogether sensible. They are based upon the principle of reproducing as far as possible the conditions of the colors as they are actually seen through the various kinds of atmospheres found along railroads and surrounding terminals. Professor Scripture writes us remarking the interesting fact that numbers of men are rejected by the wool test who are merely nervous or unaccustomed to pay attention to colors. Considerable discussion has been going on in England as to the fairness of the skein test, and questions have frequently been raised in this country on the same point. We quote from a letter from Professor Scripture: "The examination with the tester (the one we illustrate) is absolutely fair; a friend of the person to be examined may stand by his side, see the test and pass or condemn the man with as absolute and indisputable certainty as the examiner. This is an important safeguard for both examiner and examined; the test is self-evident and unquestionable. The Holmgren test is so uncertain that any one armed with the color sense tester might undertake to examine side by side with one using the wool test and show that the latter passes men who are defective and rejects men who are of sound color vision." This statement is so strong and the subject is charged with such great interests as to command immediate attention.

AIR BRAKE DECISION, WESTINGHOUSE VS. NEW YORK.

Another decision in the litigation between the Westinghouse and the New York air brake companies was handed down by the United States Circuit Court of Appeals for the Second Circuit, July 18, at New York, the decision being in favor of the New York Air Brake Co., as noted elsewhere in this issue.

The Westinghouse Co. some time ago brought suit against the New York Co. for infringement of two patents on triple valves, claiming that the triple valve brought out by the New York people in 1895, whereby the train pipe was vented to the atmosphere in emergency applications, was an infringement of Westinghouse patents. The question at issue was the right of the defendants to use this triple valve which vented to the atmosphere, and the decision was in favor of the defendants. The suit just closed was on an appeal from the previous decision and was handed down by Judges Shipman, Thomas and Lacombe, Judge Lacombe dissenting with reference to the infringement of one of the patents.

The decision may, at first, appear to be a decisive victory for the New York and a serious defeat for the Westinghouse company. Technically it is this, but really it is a success of the defendants in a plea to be allowed to make and sell brake apparatus, the inferiority of which, in comparison with the highly perfected brake of the complainants, was urged as a strong defense of non-infringement.

The standpoint from which to view this case is that of the railroad man who appreciates the importance of the air brake in the safe operation of trains and knows that the safety of fast trains depends very largely upon the ability to stop them quickly; our readers are not so much interested in the ownership of the patent rights of the appliances by which this result is attained. The question of whether the railroads will get better brakes as a result of this decision is answered in the negative, and this should be the most important question to the railroad man. The defendants have certainly not been sustained in the right to manufacture and sell an improvement in air brakes.

The defendants some time ago attempted to use the best features of the Westinghouse brake and were restrained by the courts, and their plea in this case was for the privilege of using an inferior make-shift because of commercial reasons. Their position was plainly stated in the argument of their attorney before the lower court in the following language:

"We ask Your Honor to bear in mind that these defendants,

having been badly advised formerly and having been held by this court not to be able to build a valve which has the function and mode of operation of the valve and brake system that constituted Mr. Westinghouse's great inventions of 1886 and 1887, to-day have departed entirely from that valve and are building one which does not have the supreme feature of those inventions and one which is distinctly based on the prior art; but it is a valve which they are able to sell; it is a valve that some people in the community want, and they are entitled to the full and careful consideration of the court as to whether they are or are not violating anything that these complainants are entitled to monopolize."

"The Westinghouse system to-day has twenty per cent. more power in the brake cylinder for setting the brakes than does the defendant's system; or, as some of the witnesses have said, there is fifty pounds pressure to the square inch in the defendant's system and sixty pounds to the square inch in the complainant's system; and, may it please Your Honor, the addition of that 'glant force' was made without the slightest sacrifice that was material, in the matter of accelerating the action of each individual car, or brought about by venting at the next preceding car. This is conceded."

"I ought to say perhaps that it appears in the record that by reason of the defendant's venting to the atmosphere we are able to set our brakes in a fifty-car train a quarter of a second earlier than the Westinghouse can; but what is the result? We get ten pounds less pressure in the brake cylinder; and Westinghouse sets his brakes fast enough, and we do not get all the pressure that we would like to have. The fact is . . . that these defendants have endeavored to infringe the Westinghouse patents and have been checked, properly checked and restrained by this court. They do not infringe these patents at the present time, because they have left out the substantial and important and most valuable feature of the Westinghouse air-brake system."

The effect of the decision on the air brake situation is the next question. There are several things to be considered in this connection. Air brake apparatus forms part of the permanent equipment of rolling stock and its deterioration is not like that of many other parts of the equipment that gives out all at once; it wears in such a way as to be restored by renewing comparatively small parts and the apparatus as a whole wears a long time, even perhaps outliving the structures on which it is carried. This is the reason why the most careful selection should be made in the first place. With most other apparatus about cars and locomotives mistakes may be easily remedied. Not so with brakes.

Interchange is the most vital question in car matters and it has occupied the attention of an association of bright men for thirty-three years; everybody knows the importance of interchangeability of air brakes and every one admits the vital character of this factor in train operation. Interchangeability has two sides, that of unison in operation and simplicity in the matter of repairs. The necessity for yard inspection and repairs is only just beginning to be appreciated, and unless there is good reason for making it necessary to carry several kinds of repair parts in stock, this trouble should be avoided. There is also the matter of instruction of the train and enginemen in the use of brakes. Even with the large number of instruction cars belonging to the railroads and to the air brake manufacturers it is difficult to attend to the necessary work of teaching the use and maintenance of brakes. These difficulties are multiplied by the introduction of different systems.

If a new brake is admitted to use in interchange there should be no question of its being at least equal to, if not better, than that which in point of numbers is entitled to be considered the standard. This distinction may be regarded as established when 860,000 sets of one kind are in use, or about 90 per cent. of the total number of brakes applied to the rolling stock of this country. This fact, on account of our practice in interchanging equipment, might be expected to make it difficult to introduce another system, even it were distinctly superior to the one so generally adopted. We have, however, never heard that any one has claimed that the triple valve of the defendants in this suit is superior to that of the complainants. Railroads have insisted upon the highest efficiency before all other considerations, and it is probable that they will continue to do so.

NOTES.

An immense steel rail order has been awarded to the Carnegie Steel Company for Prussian railroads. The total amount is stated to be 180,000 tons, which is the largest contract ever placed. It is to be completed in 26 months.

A good record for punctuality is reported for the fast mail on the Chicago & North Western. In 100 days the train was more than 10 minutes late only 11 times, these delays all being due to severe storms.

The importance of the steel car in the economy of railroad operation of this country is shown in an impressive way by the fact that in the month of June of this year the aggregate sales of these cars by the manufacturers amounted to one and one-quarter million dollars.

The North German Lloyd steamship "Kaiser Friederich" has been sent back to the builder, F. Schichaw, because of the failure to make her guaranteed speed of one-quarter knot per hour faster than the "Kaiser Wilhelm der Grosse." The Kaiser Friedrich is the smaller ship of the two, but has more powerful engines than the record breaker.

At the Article Club Industrial Exhibition at the Crystal Palace, Muntz's Metal Company show a collection of almost every variety of copper and brass tubes, and included in this interesting exhibit is a tube which has been taken out of a set of hardened copper tubes with tempered ends, which have been in an express engine on one of the chief British railways for 18 years, during which period it has run 480,000 miles. It is stated that the copper is as good now as when the tube was first made, and that the loss from wear and tear is only 15%.

The record of automatic block signals on the Philadelphia & Reading, published recently by the "Railroad Gazette," is remarkable evidence of the reliability of this system. We quote the following from that journal: "Their number of failures from all causes, as compared with the total number of movements of each signal, does not exceed one in 30,000. This class of failures only causes a stoppage of the train till the cause can be ascertained. The failures which are entirely erroneous [which make a signal show safety when it ought to show danger] are less than one in a million movements, a far better result than can be obtained from any system of block signals dependent on human agencies."

The new Schenectady locomotives for the Vandalia have been making some phenomenal runs. The following record, having been received from one of the higher officers of the road, is authentic: The run was made with the Vandalia train No. 20. The train passed Clayton 8 minutes late; passed Transfer Station 1 minute late, the distance being 18 miles and the time 14 minutes, which gives 46 seconds to the mile for 18 miles, or 78 miles per hour. Part of the distance was made at somewhat higher speed. For instance, Cartersburg was passed 7 minutes late, and as stated Transfer Station 1 minute late. The distance, 14.93 miles, was made at 44 seconds per mile, or 82 miles per hour. The train consisted of 8 cars. There were two postal cars, one combination coach and baggage car, two day coaches, two sleepers and one dining car. The locomotive was recently built by the Schenectady Locomotive Works, and is No. 16. It is of the 8-wheel type with cylinders 20 by 26 inches, driving wheel 78 inches in diameter, weight on drivers 85,800 pounds, total heating surface 2,241 square feet and grate surface 30.07 square feet.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS OF SCRANTON, PA.

Correspondence Instruction.

The correspondence plan of education is one of the most important and far reaching methods of instruction to-day. It takes a high place because it fills a widespread, urgent need. It provides means for improving the minds and the condition of those who without it could have no educational advantages. It educates those whose need is greatest and whose appreciation is keenest. Correspondence instruction cannot take the place of class room and lecture course, but to those who can not go to technical schools it presents the possibility of securing knowledge by aid of a logical arrangement of subjects and a definite plan of work with all of the assistance that is to be had in such courses by correspondence. The two methods should not be compared, because they are intended for entirely different classes of students.

One class devotes several years to the school exclusively, while the other studies during the hours not occupied in the shop at the bench, running or firing locomotives, or in other forms of labor. The correspondence school is necessarily less thorough, but it has a decided advantage in the fact that its students know exactly what they want to study, and also because their purpose is fixed and firm. It has a philanthropic side in that the workers in low grades are assisted to raise themselves to higher ones. Its success depends chiefly upon the earnestness of the student, and one who is willing to work hard during the hours allotted to rest and recreation is likely to profit to the utmost from the advantages offered. The plan proves itself to be good by its success, and it should be supported by all railway officials who have charge of the work of young men by encouraging them to improve themselves in this way. Those who are struggling along and studying single handed are wasting time that may be saved by taking up a correspondence course, written by a specialist who devotes his entire attention to the preparation of the papers.

A representative of the American Engineer and Railroad Journal visited the International Correspondence Schools with a preconceived idea that the correspondence plan of education could not accomplish all that has been claimed for it, but a thorough examination of the aims and methods changed this opinion to the point of enthusiastic endorsement, and the same result must be reached by practical railroad men or manufacturers upon looking over the system carefully as it is carried out at these schools, which are largest and most successful example of schools of the correspondence plan.

The Scranton Schools.

We illustrate the main building of these schools because of its architectural beauty and its admirable appointments. The provisions for light and ventilation are specially noteworthy.

The institution had its origin in the correspondence columns of the "Colliery Engineer and Metal Miner," now published at

the schools as "Mines and Minerals," by the Colliery Engineer Co., of which Mr. T. J. Foster is Manager.

The schools were started in 1891 as a result of the demand among miners for educational privileges necessary to enable them to pass the examination required by the mine laws. Mining was the first subject taught and by a single instructor, who made a study of the requirements of the applicants and adapted the instruction accordingly. Other subjects were added and the number of enrollments February 20, 1899, was 76,667; at present the number is over 90,000.

Courses of Instruction.

The student must be able to read and write. The courses are planned with great care and the instruction papers are presented in small installments in order to avoid discouraging the students. All students starting at the bottom are required to take elementary arithmetic. There are 57 separate courses, each of which is prepared in the form of pamphlets accom-

panied by sets of questions and answers. The pamphlets are prepared with special reference to the qualification of the students, their chief characteristic being clearness and simplicity of statement and illustration. The student answers the questions in instalments and the papers are examined, corrected and returned. The instruction papers are also furnished in bound volumes early in the courses, for permanent text books, which are indexed and may be used for reference. The student may copy the answers to all the questions, but this is not often done by those who are earnest enough to engage in work of this kind. The mechanical drawing lessons cannot be copied, because the work is required to be done to a different scale from that used in the originals. Mechanical drawing is one of the most popular subjects, and the instruction book seems to be admirably adapted to its purpose. The papers are marked with evident care and the students ask whatever questions they desire. It is assumed by the writers of the



INTERNATIONAL CORRESPONDENCE SCHOOLS.

General Offices.

courses that the student at first knows nothing about the subjects, and for this reason the instruction is not "over the heads" of the students.

Those who mark the papers in any course have taken that course themselves, and difficult and unusual questions are referred to the specialists, who write and revise the instruction papers. Those who desire may go as deeply into any of the subjects covered by his course as the correspondence plan will permit. No time is set for the completion of a course, but students are encouraged to progress constantly, even if slowly. A special department is provided for the benefit of the totally uneducated, as, for example, a miner who never had a chance to go to school and cannot add or subtract. There are such now enrolled and this part of the work touches philanthropy.

The courses are not all above criticism, but the fact that they are unique in literature must be taken into consideration by the critic. The plan provides for frequent revision and improvement. The air brake instruction books are admirably written and the engravings are remarkable. The locomotive

and car courses are being revised and they will be greatly improved.

Diplomas are given at the completion of courses.

The Plant.

The organization and plant are extensive and interesting. There are departments for everything from the solicitation of students to the employment bureau and local office. There are about 1,000 employees, and in addition to the unique equipment at Scranton, representatives are traveling all over the country in three cars built especially for the purpose of exhibiting the work and explaining the advantages of the schools. The building and equipment at Scranton cost \$250,000, and recently an entire city block, near by, has been purchased for the purpose of building a printing establishment sufficiently large to do all the printing for the schools. The home equipment is impressive, but there are as many employees "on the road" and connected with local offices as are employed at Scranton.

Students.

The average age of students at present is 25 years. They are in many cases ambitious young men, and many of them obtain free tuition by securing the enrollment of others. The expense is not great and a system of instalment payments is arranged. Every student's record is kept, in order to permit of reporting advancement to employers and to be used in recommending students for positions. Many employees in drafting rooms are enrolled, also apprentices in shops, firemen on locomotives, and even technical school graduates who desire to take up subjects not covered by them when at school or to brush up on subjects which they have studied. It would be a good plan to require all shop apprentices to take a correspondence course as a part of the requirements for admission to the shop, and the employer will be rewarded if he pays the tuition.

Publications.

In connection with the schools four periodicals are published, viz.: "Mechanic Arts Magazine," "Steam and Electric Magazine," "Building Trades Magazine," and "Mines and Minerals." The editors are in touch with the work of the schools and are available in consultation concerning the instructive work.

Officers.

The officers of the institution are: Mr. R. J. Foster, President; Mr. T. J. Foster, Manager and Treasurer, and Mr. E. H. Lawall, Vice-President. The schools are controlled by the Colliery Engineer Company, incorporated under the laws of Pennsylvania, with a paid up capital of \$1,250,000. The manager, Mr. T. J. Foster, is the originator of the schools. To his management the success of the institution is due. He is also the pioneer in correspondence instruction, and while the schools are carried on because they "make money," the management is entitled to credit for building up a most useful and necessary institution.

It is bad practice to empty boilers under steam pressure, when they have to be cleaned, to remove the deposit adhering to the boiler plates. This is the usual method with stokers, but there are two great inconveniences connected with it. The internal surfaces of the boiler plates are exposed to radiation from the hot surrounding brickwork, and the deposit during the process of emptying adheres to them and cannot be removed except by hammering. In the second place the riveted joints, affected by the radiation, and no longer covered with water, soon have a tendency to leak. Boilers should never be emptied until the steam pressure has fallen to about 1 atmosphere, or even less, and should be allowed if possible to become quite cold. The process of cleaning them thus, by means of a hose and water-jets, after carefully drawing off the water, is due to Mr. Savreux of Amiens. Since 1886 it has been used for many boilers in France, and they have always been found very clean inside afterward, the deposit comes away easily, and there is no necessity for chipping. To cool a boiler completely, when surrounded by brickwork, takes about 8 days altogether. After 3 days the flues can be cleared of the cinders and soot, and this helps to cool the water. A small steel scraper will be found useful to remove the harder deposit.—Inst. C. E. Foreign Abstracts.

PERSONALS.

Mr. T. E. Harwell has been appointed Master Mechanic of the Southern Railway at Mobile, Ala.

Mr. D. A. Williams has been appointed General Storekeeper of the Baltimore & Ohio, with headquarters in Baltimore.

Mr. R. W. Morgan has been appointed Purchasing Agent of the Wagner Palace Car Company, to succeed the late D. O. Talbot.

Mr. William C. Pennock, formerly Master Mechanic of the Southwest system of the Pennsylvania at Logansport, Ind., was drowned July 17.

Mr. David Van Alstine has been appointed Master Mechanic of the Chicago Great Western to succeed Mr. Tracy Lyon, who has been promoted.

Mr. A. Hendee has been appointed Master Mechanic of the Panama Railroad, with headquarters at Colon, Colombia, succeeding Mr. Percy Webb, resigned.

Mr. F. W. Main has been appointed Purchasing Agent of the New Orleans and Northwestern, with headquarters at Natchez, Miss., succeeding Mr. C. G. Vaughn.

Mr. Thomas Fielden has been appointed Assistant Master Mechanic of the Missouri Pacific, with headquarters at Cypress, Kan., to succeed Mr. W. T. New, resigned.

Mr. Steven A. Gardner, general Superintendent of the Marine Division of the New York, New Haven & Hartford Railroad, died suddenly, of apoplexy, on July 9.

Mr. W. H. Reilly has been appointed Master Mechanic of the Fort Worth & Rio Grande, with headquarters at Fort Worth, Tex., to succeed Mr. T. J. Shellhorn, resigned.

Mr. G. T. Sanderson has been appointed Master Mechanic of the Montana division of the Great Northern, to succeed Mr. J. McGie. His headquarters are at Havre, Mont.

Mr. H. F. Ball has been appointed Mechanical Engineer of the Lake Shore & Michigan Southern. He was formerly General Car Inspector and the position has been abolished.

Mr. J. McGie, Master Mechanic of the Montana Division of the Great Northern, has been made Master Mechanic of the Montana Central, a tributary line to the Great Northern.

Mr. J. W. Stokes has been appointed Master Mechanic of the Omaha, Kansas City & Eastern and Omaha & St. Louis, with headquarters at Stanberry, Mo., to succeed Mr. C. A. DeHaven.

Mr. M. J. Spaulding has been appointed Master Mechanic of the Washington County Railroad at Calais, Me. He was formerly Road Foreman of engines on the Atlantic Division of the Canadian Pacific.

Mr. George W. Taylor, formerly Master Mechanic of the Wisconsin & Michigan Railway, has been appointed Master Mechanic of the Copper Range Railroad, with headquarters at Houghton, Mich.

Mr. P. L. Cochrane, formerly Master Mechanic of the Central of Georgia at Columbus, Ga., and later Master Mechanic of the Seaboard Air Line, died at Atlanta, Ga., on July 4, at the age of seventy-one years.

Mr. Tracy Lyon, Master Mechanic of the Chicago, Great Western, has been appointed General Superintendent of that road, with headquarters at Saint Paul, Minn., in place of Mr. Raymond Du Puy, resigned.

Mr. I. Knapp, general foreman of the Buffalo shops of the Lehigh Valley, has been promoted to succeed Mr. J. S. Chambers as master mechanic.

Mr. H. K. Bates, Master Mechanic of the Fort Scott and Springfield divisions of the Kansas City, Fort Scott & Memphis, has resigned that position on account of ill health, after a service of 29 years with this road.

Mr. Charles H. Quereau, Master Mechanic of the First Division of the Denver & Rio Grande, has been appointed Assistant Superintendent of Machinery and Acting Master Mechanic of that division, with headquarters at Denver, Col.

Mr. J. T. Stafford has been appointed Acting Division Master Mechanic of the St. Louis, Iron Mountain & Southern, a tributary line of the Missouri Pacific, with headquarters at Baring Cross, Ark., succeeding Mr. Mord Roberts, resigned.

Mr. W. J. Miller has resigned as Master Mechanic of the Southern Division of the Kansas City, Pittsburg & Gulf at Shreveport, La., and Mr. C. A. DeHaven, formerly of the Omaha, Kansas City & Eastern, has been appointed to succeed him.

Mr. George H. Campbell, Terminal Agent at Baltimore of the Baltimore and Ohio Railroad, has been appointed Assistant General Superintendent, with headquarters at Baltimore. Mr. Campbell came to the Baltimore and Ohio Railroad three years ago from the Big Four.

Mr. William A. Patton, Assistant to the President of the Pennsylvania Railroad, and Vice-President of the New York, Philadelphia & Norfolk, has been elected President of the latter road, succeeding Mr. A. J. Cassatt, who has resigned upon election to the Presidency of the Pennsylvania.

Upon the resignation of Mr. W. V. Clark, Superintendent of the Southern Division of the Central Railroad of New Jersey, his associates and the employees of the division tendered him handsome testimonials, the presentation address being made by Mr. William M. Montgomery, Master Mechanic at Lakehurst.

William H. Stearns, one of the veteran motive power officers of New England, Master Mechanic of the Connecticut River Road, died in Springfield, Mass., July 14, at the age of 77. He was Master Mechanic of this road from 1872 until its absorption by the Boston & Maine in 1895. His railroad service began under Wilson Eddy on the Boston & Albany in 1842.

Mr. E. E. Davis, who recently resigned as Assistant Superintendent of Motive Power of the Philadelphia & Reading to accept a similar position on the New York Central, was met by his former subordinates on leaving his office in Reading and presented with a testimonial in the form of a handsome watch as a token of esteem. Mr. Davis responded with words of commendation and appreciation of the efforts of his assistants.

Mr. Samuel F. Prince, Jr., has tendered his resignation as Superintendent of Motive Power of the Long Island, to succeed Mr. L. B. Paxson as Superintendent of Motive Power and Rolling Equipment of the Philadelphia & Reading. Mr. Prince was formerly Mechanical Engineer of the Philadelphia & Reading, and has been with the Long Island for nearly eight years. He is a graduate of the University of Pennsylvania.

Mr. L. B. Paxson, Superintendent of Motive Power and Rolling Equipment of the Philadelphia & Reading, has been appointed Consulting Mechanical Engineer of that road, a position which was made for him in order to relieve him from the arduous duties which he has performed for many years. Mr.

Paxson is one of the veteran motive power officers and has been connected with the Reading since 1847, when he began as a freight brakeman. He has been in charge of the motive power department for the past 11 years.

George W. Morris, who for many years represented the interests of the A. French Spring Company, died after a very brief illness at his home in Virginia, July 8. He had not been in active business for some time, and at the recent convention at Old Point Comfort he appeared to be enjoying very good health. Mr. Morris had an unusually wide acquaintance from his long service in the railroad supply business, and there are few men who will be missed as he will. He was a regular attendant at the conventions and had missed but one convention since the two associations were started.

Mr. W. F. Hallstead, Second Vice-President and General Manager of the Delaware, Lackawanna & Western, has resigned after nearly fifty years of railroad service. He was born in Pennsylvania in 1837 and began railroad work as a water boy at the age of 15. He passed through the different grades of train service until he became General Manager, and in 1897 the title of Second Vice-President was given him. He is strong in the grasp of the minor details of operation and knew his subordinates thoroughly. His application to his work is remarkable. He was usually in his office at 6 o'clock in the morning and remained until 5 in the afternoon, with but a brief interval at noon for lunch. He also was accustomed to work from 7 until 9 in the evening at his desk.

New York Central motive power changes are as follows: James Buchanan of West Albany, N. Y., and G. H. Haselton of Depew, N. Y., heretofore Assistant Superintendents of Motive Power, have been appointed Division Superintendents of Motive Power. P. T. Lonergan, heretofore Master Mechanic, has been appointed Division Superintendent of Motive Power on the Rome, Watertown & Ogdensburg Division. The jurisdiction of James Macbeth, Master Car Builder at East Buffalo, N. Y., has been extended over the entire Western Division. The office of Master Car Builder at Rochester, N. Y., has been abolished. The jurisdiction of F. W. Chaffee, Master Car Builder at West Albany, N. Y., has been extended over the Middle Division, and the jurisdiction of S. T. Case has been extended over the Hudson Division. The headquarters of George Thompson, Division Superintendent of Motive Power, has been transferred from Jersey Shore, Pa., to Corning, N. Y.

Mr. John A. F. Aspinall, who has ably filled the position of Chief Mechanical Engineer of the Lancashire & Yorkshire Railway, England, has been appointed General Manager of that road, and is succeeded by Mr. H. A. Hoy. Mr. Aspinall's appointment is the first instance of the selection of a general manager of an English road from the mechanical department. This is an important and pleasing precedent which is worthy of attention in this country. The mechanical officers have most exacting administrative responsibilities, which appear to fit them admirably for the charge of general management, and the encouragement which a prospect of further advancement would offer could not fail to further improve their administration of their departments. At present there seems to be nothing for the mechanical officials to look forward to in the way of advancement, and yet it is from this part of railroad operation that most is expected in the line of economics.

Mr. John R. Slack has resigned as Mechanical Engineer of the Central Railroad of New Jersey to accept the appointment of Assistant Superintendent of Motive Power of the Delaware & Hudson, with headquarters at Albany. After graduating from Columbia College in 1884, he entered Stevens Institute of Technology and graduated with the degree of M. E. in 1886. He then entered the shops of the New York Central as an ap-

prentice and afterward went to the Frankfort shops of the West Shore as draftsman, under Mr. James M. Boon. In 1890 he became inspector of locomotives for the New York Central and was soon made chief draftsman and later Mechanical Engineer under Mr. William Buchanan. In 1898 he was appointed Mechanical Engineer of the Central Railroad of New Jersey. Mr. Slack was sent abroad by the New York Central in 1896 and made a study of Austrian, French, German and English railroad methods, giving especial attention to the railroads of Austria.

Mr. James M. Barr has tendered his resignation as Vice-President and General Manager of the Norfolk & Western Railway to take charge of the operation of the Atchison, Topeka & Santa Fe Railway System, as Third Vice-President. He began railroad work as a messenger in the office of one of the Superintendents of the Pennsylvania Railroad, and after service in various departments of several roads he was made Superintendent of the Chicago, Burlington & Northern Railway in 1885, since which time he has been employed as Superintendent by the Union Pacific, Chicago, Milwaukee & St. Paul and Great Northern roads, and by the latter road as General Superintendent. He was made Vice-President and General Manager of the Norfolk & Western Railway in February, 1897, and has held this position since. Mr. Barr is a successful operating officer, and while he is a comparatively young man, he has few superiors in the application of business principles to the management of transportation. His success is chiefly due to an exact knowledge of the present costs, from which to base future improvements, combined with a system of management whereby his subordinates are kept constantly informed as to the results of their work. While this is the basis of administration of successful business enterprises in other fields, it is not often seen in railroad work. Mr. Barr has now reached a high place as a railroad officer, but he will go still higher as a result of his clear-headedness, his tireless energy and exclusive devotion to his profession.

THE INTERNATIONAL RAILWAY CONGRESS.

The sixth session of the International Railway Congress will probably open on or about Saturday, September 15, 1900, although the exact date has not yet been fixed. It will be held in the "Palace of Congresses" of the Exposition, Paris.

There have been admitted to temporary membership in the International Commission of the Congress twenty-three French railway officials having special reference to the arrangements for the sixth session. Mr. Paul Brame is Secretary to the Local Committee.

The American members of the International Commission are Chas. P. Clark, New York, New Haven & Hartford; Chauncey M. Depew, New York Central & Hudson River; Theo. N. Ely, Pennsylvania; and Frank Thomson, Pennsylvania.

The American "Reporters" on the questions to be discussed are as follows:

Nature of the Metals for Rails.—P. H. Dudley, Inspecting Engineer, New York Central & Hudson River.

Locomotives for Trains Run at Very High Speed.—Axel S. Vogt, Mechanical Engineer, Pennsylvania.

Use of Steel and Ingot Iron in the Construction of Locomotives and Rolling Stock.—Chas. B. Dudley, Chemist, Pennsylvania.

Brakes and Couplings of Carriages and Wagons.—Geo. W. West, Superintendent Motive Power, New York, Ontario & Western.

Economical Size of Goods Trucks or Capacity of Freight Cars.—L. F. Loree, General Manager Pennsylvania Lines West of Pittsburgh.

Electric Traction.—N. H. Heft, Chief of Electrical Department, New York, New Haven & Hartford.

Handling and Conveyance of Broken Loads.—J. H. Olhausen, General Superintendent Central of New Jersey.

Automatic Block System.—E. C. Carter, Principal Assistant Engineer Chicago & Northwestern.

Railway Clearing Houses.—G. R. Blanchard.

Technical Education of Railway Servants, Appointment and Promotion.—Geo. B. Leighton, President Los Angeles Terminal.

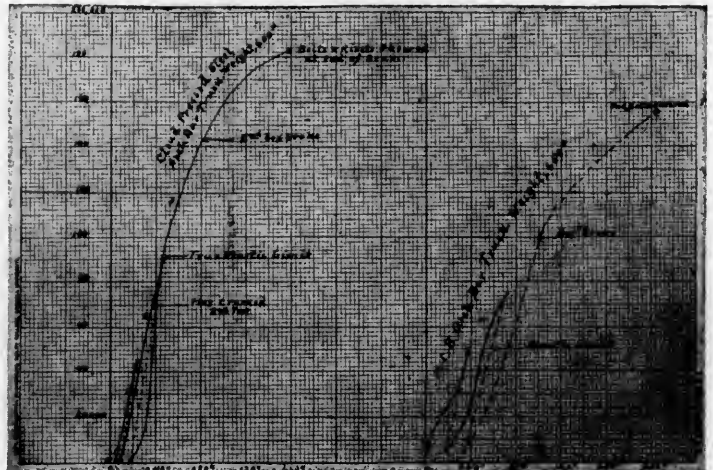
Conveyance of Farm Produce to Stations on the Main Railways.—J. T. Harahan, Second Vice-President Illinois Central.

—[Reprinted from the Official Guide.]

CLOUD PRESSED STEEL ARCH BAR TRUCK.

A new steel truck designed and patented by Mr. John W. Cloud, built and exhibited at the recent conventions by the Cloud Steel Truck Company attracted considerable attention. While the plate side frame has many advocates among railroad men, there are others who prefer the diamond side frame, and the purpose of this design was to supply this form, using a stronger and lighter structure than is to be had with rectangular arch bars.

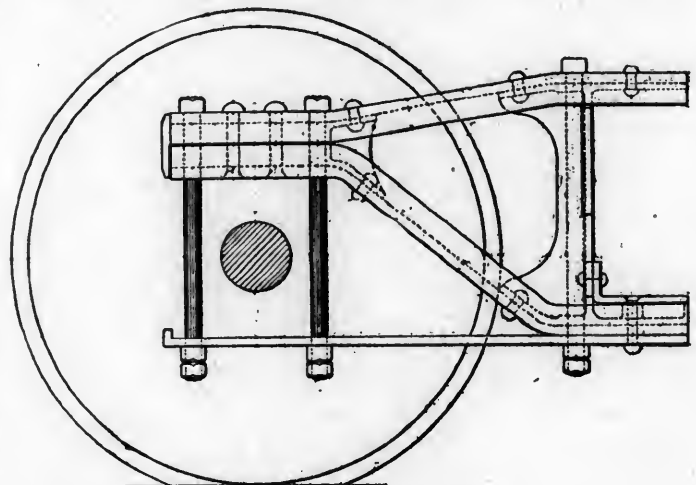
The common form for bending the arch bars has been retained and also the rectangular tire rod. The upper and lower arch bars are made of channels rolled with a section which



Strain Diagram.

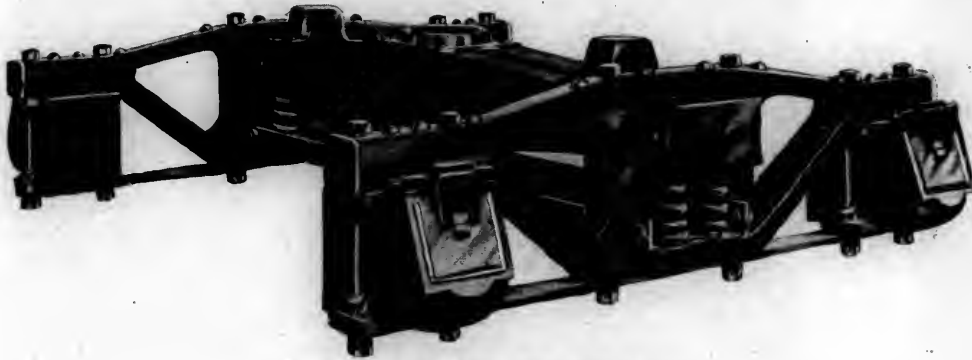
Comparative Test of Cloud Pressed Steel Arched Bar Truck and M. C. B. Arched Bar Truck.

is specially adapted to bending into the desired form. This, it is stated, could not be so well done with any of the present commercial shapes, because of the stiffening effect of the large fillets. The ends of the arch bars are united by means of malleable castings formed to fit the channels. These castings terminate in a flange at the outer ends, forming bearings for the ends of the channels and at the inner ends they give sup-

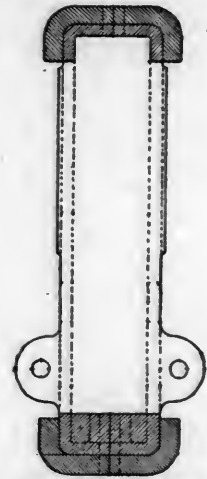


Half Elevation of Side Frame.

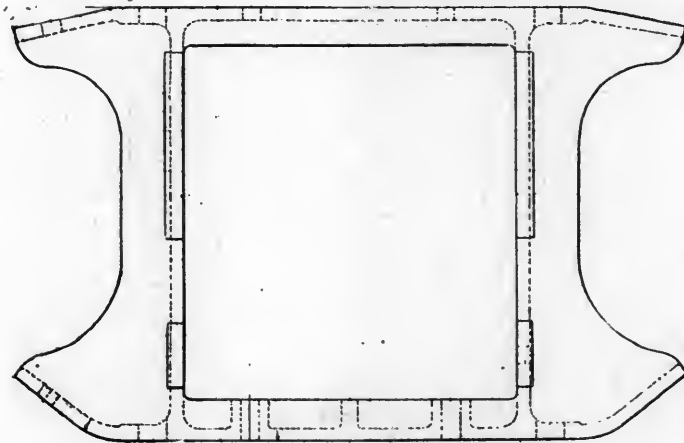
port to the arch bars at and slightly beyond the points of curvature. The column guides are also in the form of a malleable casting, to which the arch bars are riveted. These castings also extend beyond the points of curvature of the arch bars. With this feature and the riveting which is reinforced by the column bolts and journal box bolts, the structure may be expected to give a good account of itself. The column bolts are



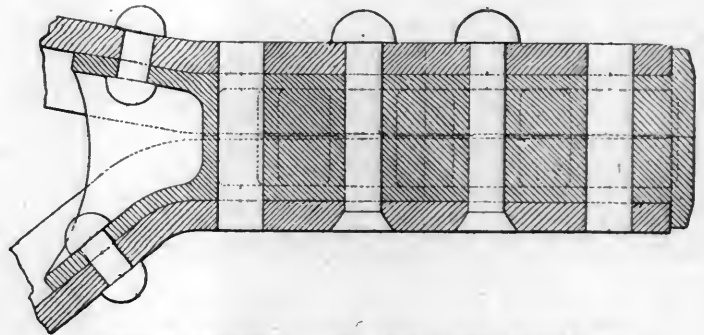
Cloud Pressed Steel Arch Bar Truck.



Section Through Column Casting.



Side Elevation of Column Casting.



Section Through Filling Block Over Journal Box.

1½ inches in diameter, the reduction being possible on account of the riveting.

In a recent test at the laboratory of the Armour Institute of Technology, Chicago, one of these diamond frames intended for a car of 80,000 pounds capacity held a load of 90,000 pounds before reaching the elastic limit. An ordinary diamond side frame tested at the same time reached its elastic limit at 45,000 pounds, when it failed by the shearing of the box bolts and the end rivets.

It is easy to see the advantage of the channel over the rectangular form for compression members, and those subjected to bending, but the riveting, the support given to the bends in the arch bars and the reinforcement at the ends are equally important factors in this truck. We are not told the weight of this side frame, but it is probably much less than that of the ordinary diamond frame.

AJAX METAL COMPANY'S NEW BEARING METAL.

Some five years ago the Ajax Metal Company added to its large list of special alloys for railroad and other purposes an alloy which is especially intended for the heavy coaches of fast trains. This alloy was the result of many careful experiments and many observations in the practical usage of compositions intended for similar purposes.

After many trials and many failures a composition was reached which fully met the requirements of such service. So sure were the manufacturers of the merits of their new material before placing it on the market, that they declared their willingness to contract with railroads for brasses made of this composition, guaranteeing to replace free of cost all brasses which should run hot. Several such contracts are now held with the largest users of journal brasses in the country, and we are glad to say that these brasses are supporting the claims which the manufacturers are making for them in a wonderful manner.

We can readily see how such a liberal contract can be entered into when 3,200 scrap brasses, which were recently returned to the foundry, were inspected by the consumers' inspectors, and only 20 brasses required replacement, showing a percentage of hot brasses equal to less than one per cent.

The Ajax Metal Co. is willing to enter into contracts with all consumers of bearing metals on this basis, and is able to quote a price which is by no means the highest which is being paid, but is considerably below this, although in actual value it may be double what roads are paying for inferior material.

This metal is in regular use by a railroad whose service is the hardest in the country, not only in the weight of cars, but also for its long distance runs, its varied roadbed and varied conditions of soil through which the lines pass. This company requires the Ajax Metal Company to replace less than one per cent. of the brasses furnished them.

The excellent service given by this alloy, it is claimed by the manufacturers is due to its homogeneity of structure, and to the plasticity of its particles. Although a hard metal, and well able to withstand the weight of the heaviest coaches, its particles or constituents show great plasticity. Figuratively speaking, the journal made of this material is like a stiff rubber cushion, which supports its load without squashing, but at the same time is plastic enough to adapt itself to the irregularities of the journal, and to prevent the rapid wearing away of its particles.

The great French philosopher, Voltaire, once asked this riddle: "What is the longest and yet the shortest thing in the world; the swiftest and the most slow; the most divisible and the most extended; the least valued and the most regretted; without which nothing can be done; which devours everything, however small, and yet gives life and spirit to everything, however great?"

The American Engineer and Railroad Journal will be sent free for one year to the person from whom the first correct answer is received, by mail at the publication office.

A COURT HOUSE "GOING TO COURT" VIA THE BURLINGTON.

House moving by rail is always interesting, but when a railroad loads up a "county seat" and carries it on a train without laying out regular traffic, the achievement is worthy of record. This is an instance of responsible work done by the local division authorities of the Burlington & Missouri River Railroad, and the following is quoted from a letter to this journal, from an officer of that road, which accompanied photographs from one of which our engraving was made:

"The feat was that of transporting by rail the county seat at Hemingford, Box Butte County, Neb., to Alliance, Box Butte County, Neb., a distance of 19 and a fraction miles. By popular vote the county seat was changed some months ago from Hemingford to Alliance. How it was accomplished hardly

being about six miles per hour. Several of the cuts had to be widened in order to let the corners of the building past. It was through loose earth and not much of a job.

"The Hon. J. Sterling Morton happened to be in that vicinity when this transfer was made and dryly remarked that it was the first time he ever saw a court house going to court."

The building weighed about 70 tons and its dimensions were 34 by 48 feet and 45 feet high.

A record of 1,310 tons of steel in a single run has been made at the south mills of the Illinois Steel Co. in Chicago. The men who did this work were those of the regular night shift and were not selected for the occasion.



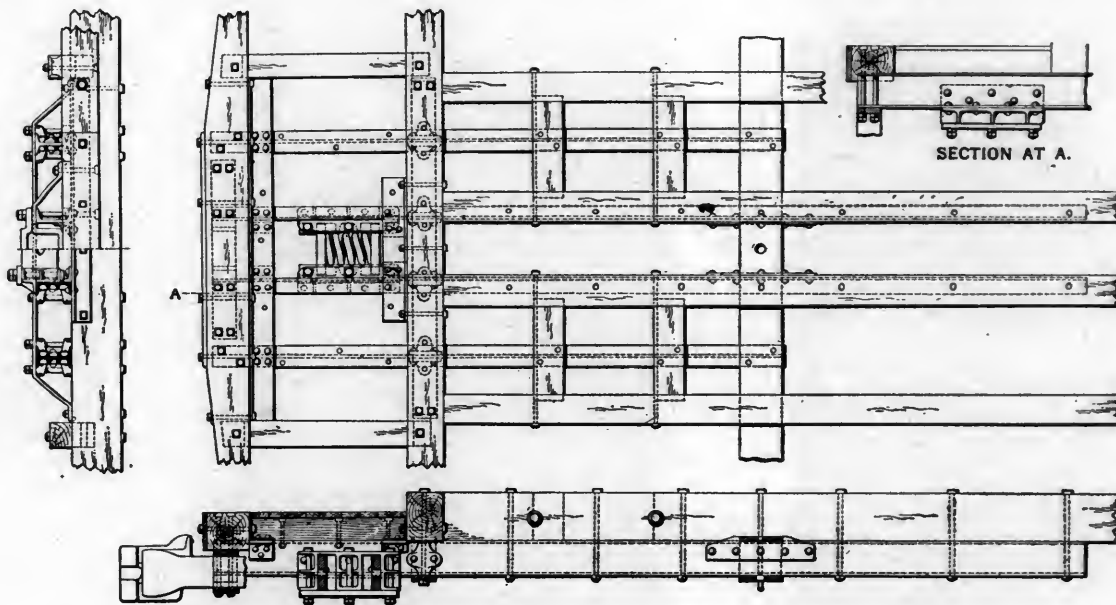
Moving a Building by Rail.
Burlington & Missouri River R. R.

needs explanation, as the photographs explain for themselves. The building was placed on four 60,000 pound capacity trucks. You will observe from the pictures that two loaded coal cars are in front and the same number back of the house. These coal cars served the purpose of anchors to which the building was guyed by ropes. Heavy bridge timbers were secured to the lower part of the court house and supported on the trucks. One difficulty that had to be provided for was that of passing trains. To avoid any inconvenience the first part of the journey was made from Hemingford to Berea, the outfit being allowed to remain for the night on the main track, and the through trains east and west ran around it on yard tracks at that point. The following morning, after the trains had all passed, the court house continued its journey to Alliance, reaching there about noon, June 30. In noting the speed it was observed that country wagons, in order to keep up with the speed of the building, had to move along at a trot, the speed

The presidents and executive officers of the Pennsylvania and its Western connections at a meeting held in New York, June 28, adopted a resolution concerning the late President Frank Thomson, of which the following is a part: "Death has again visited our association and removed from our midst one of its choicest spirits. The name of Frank Thomson has for many years stood for everything that is good. A man of simple and lovable character, he rose to the very zenith of his profession, and, having attained the highest rung of the ladder, he extended to all the climbers below naught but words and deeds of encouragement and cheer. From out of all the wranglings and strife of our modern competitive life no memory remains of this gentle, loving man but that which is sweet and precious to those of us who remain. His death removes from among us a wise counselor and friend, and those of us who were associated with him in life will long cherish his memory as a sacred and loving heritage."

THE STANDARD STEEL CABOOSE PLATFORM.

Mr. H. H. Sessions, Vice-President of the Standard Coupler Company, has designed a new steel caboose platform, which is manufactured by that company. This is a result of the success of the Standard steel platform as applied to passenger cars, the introduction of which has been quite general on many important railroads. Its object is to prevent the sagging of the platforms of cabooses on account of the rough treatment these cars receive. The usual wooden, longitudinal timbers are replaced by steel I beams extending from the platform end sill through the body bolsters. The attachment to the body bolsters and their extension beyond these members relieves the car end sills from a large part of the stresses formerly carried by them. The platform beams are secured at the end sills by bolts passing through the flanges of the I beams and through malleable iron castings riveted to the webs of the beams. No truss rods are used and the form of construction selected gives lateral and vertical strength far superior to that obtained with



New Steel Caboose Platform—The Standard Coupler Company, New York.

timber construction. This platform is now in use on the Illinois Central, the Chicago, Rock Island & Pacific, the Oregon Short Line, the Chicago, Peoria & St. Louis, the Minneapolis & St. Louis and the Chicago Great Western.

POSITIVE EXPANSION BOLT.

An expansion bolt for the use of railroads, architects, engineers and others who require a "hidden resistance," has been successfully introduced and is manufactured by Daniel C. Seaman & Co., 1638 Hutchinson Street, Philadelphia, Pa. The bolt is threaded on both ends and the end to be fixed in the wall or similar location carries a circular nut recessed, on its inner face, to receive the outer ends of two wings which are nearly semi-circular in cross section. The wings are held in such a way as to insure the bolt from pulling out. They tighten their hold by spreading when the load is applied, and yet the bolt and fastening may readily be removed from the hole by applying a wrench to the outer end of the bolt. The chief claims made for the device are its tightness, easy application and easy removal. It has been successfully applied to stone and brick work, for smoke stack guys, fastenings for fire escapes, engine bed bolts when secured to solid rock or masonry; also for bridge work, window and door frames and elevator guide tracks in buildings. It is stated that the bolts become firmer as the strain is increased.

ROLLING STOCK STATISTICS.

The advance sheets of the report of the Interstate Commerce Commission, dated July 5, 1899, contain the following information with regard to rolling stock:

On June 30, 1898, there were 36,234 locomotives in the service of the railways. This number is larger by 248 than the previous year. Of the total number of locomotives reported, 9,956 are classed as passenger locomotives, 20,627 as freight locomotives, and 5,234 as switching locomotives, a small number being unclassified. The total number of cars of all classes reported as in the service of railways on the date named was 1,326,174, being an increase of 28,694 as compared with June 30, 1897. Of the total number, 33,595 were assigned to the passenger service and 1,248,826 to the freight service, 43,753 being assigned to the service of the railways themselves. The number of cars owned by private companies and individuals that are used by railways in transportation is not covered by reports filed with the Commission.

An inspection of the summaries which are designed to show the density of equipment and the efficiency of its employment,

shows that during the year ending June 30, 1898, the railways in the United States used 20 locomotives and 718 cars per 100 miles of line. Referring to the country at large, it appears that 50,328 passengers were carried, and 1,343,906 passenger-miles were accomplished per passenger locomotive, and 42,614 tons of freight were carried, and 5,530,498 ton-miles accomplished per freight locomotive. All of these items show an increase as compared with those of the previous year ending June 30, 1897.

Including under the term equipment both locomotives and cars, it is noted that the total equipment of railways on June 30, 1898, was 1,362,408. Of this number 641,262 were fitted with train brakes, the increase being 115,976, and 909,574 were fitted with automatic couplers, the increase in this case being 230,849. The summaries indicate that practically all of the locomotives and cars assigned to the passenger service are fitted with train brakes, and that out of a total of 9,956 locomotives assigned to this service 5,105 are fitted with automatic couplers, and 32,697 cars out of a total of 33,595 cars in the same service are also so fitted. A corresponding statement for freight equipment is as follows: Out of a total of 20,627 locomotives assigned to the freight service 19,414 are fitted with train brakes and 6,229 with automatic couplers, but out of a total of 1,248,826 cars assigned to the freight service only 567,409 are fitted with train brakes and 851,533 with automatic couplers. The number of switching locomotives fitted with train brakes was 3,877, and the number fitted with automatic couplers was 1,199. Of the total number of cars of all classes in service on June 30, 1898, 607,786 were fitted with train brakes, the increase during the year being 115,227, and 896,813 were fitted with automatic couplers, the increase in this case being 227,876.

NEW SIX-ROLL DOUBLE CYLINDER PLANING AND MATCHING MACHINE.

J. A. Fay & Co., Cincinnati, Ohio.

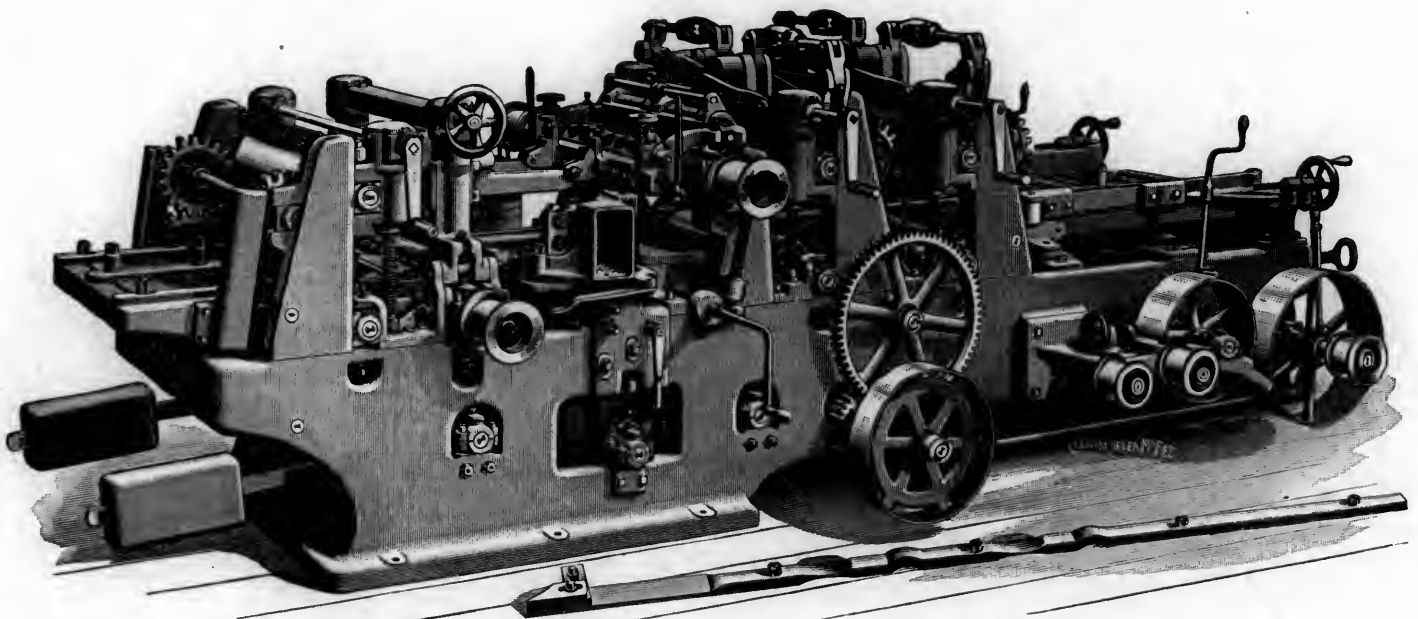
This new machine is specially designed for use in car shops and for general planing mill purposes. It has a wide range of work, planing four sides up to 30 inches wide and 8 inches thick, and it will work three sides of two pieces simultaneously, even when they are of uneven thickness, up to 12 inches wide and 8 inches thick.

The frame is very massive and that portion supporting the working parts is braced by a long sole-plate or girt. All parts are accurately planed and joined by heavy bolts. A system of interchangeable parts and standard sizes is adhered to throughout by the builders.

The cylinders are two in number, made from solid steel forgings, and have four faces slotted to receive two or four knives, and chip-breaking lips for working cross-grained lumber. The upper cylinder is mounted in a heavy yoked frame, has jour-

ment very easy, as the pressure weights do not have to be lifted. The upper feed rolls in front of the upper cylinder are divided in the center for the purpose of feeding simultaneously two pieces of material of uneven thickness through the machine. These divided rolls are heavily weighted, and may be aligned at any time by the new lift, or adjusted out of line with the platen to lead the lumber to the center guide. All roll boxes are long and large in diameter. The feed-out roll is provided with scrapers. The weight levers are inside the frame, and move with perfect freedom. It has three speeds of feed, viz., 30, 45 and 60 feet per minute. The feed is under instant and positive control of the operator by means of a lever engaging a ring friction.

The pressure bar in front of the upper cylinder is divided and adjustable to and from the cut, and has chilled toes, reducing wear to a minimum. The bar behind the cut is adjustable for difference in thickness of material worked. The bars in front of and behind the lower cylinder are adjustable to and from the cut, and are vertically adjustable for varying depths of cut. The bar over the lower cylinder is adjustable



Six-Roll Double Cylinder Planing and Matching Machine.
J. A. Fay & Co.

nals $2\frac{1}{4}$ inches in diameter, and runs in self-oiling bearings $10\frac{1}{2}$ inches long. The cylinder-raising screws are outside of the frame and are fitted with ball bearings and a device for quickly taking up all lost motion in the screw caused by the wear of the threads. The lower cylinder is mounted in a heavy yoked frame, has $2\frac{1}{4}$ -inch journals that run in self-oiling bearings $10\frac{1}{2}$ inches long, and is vertically adjustable at each end.

The matching works are heavy. The arbors are of steel $1\frac{3}{4}$ inches in diameter where the cutter-heads are applied, and revolve in long bearings, both of which are adjustable vertically and horizontally, and are rigidly locked in any desired position by a lever conveniently located outside the frame. The top plate of each matcher hanger is detached from the main casting for convenience and economy. The machine will match stock from 2 to 30 inches wide.

The feed works consist of six large feed rolls 8 inches in diameter, driven by a train of powerful gearing, each gear on a shaft extending through the machine and running in babbitted bearings. The expansion gears on the feed rolls are inside the frame, and run in bearings. The screws for raising the rolls do not revolve, the rolls being mounted in sleeve housings that travel on the screws. This makes the roll adjust-

on heavy stands, and is securely locked in position. It can be swung over from either side by simply loosening one nut. Continuous pressure bars extend over the matching works with independent adjustment, and they may be quickly thrown out of the way to give access to the heads.

This machine is equipped with a new and improved belt-tightening apparatus for both cylinder and side-head belts, quickly adjustable while the machine is running, and permitting the use of endless belts, that run more smoothly and do not require to be cut for the stretch to be taken up. By the use of this apparatus 2-inch stock may be matched, and the belts stand at least 10 inches apart on the countershaft.

The address of Messrs. J. A. Fay & Co. is 516 to 536 West Front Street, Cincinnati, Ohio.

THE GILMAN-BROWN EMERGENCY KNUCKLE.

This device is intended for use in cases of failure of the knuckles or locking devices of M. C. B. couplers. It is a steel casting weighing 52 pounds, and the long tail of the knuckle passes into the cavity of the draw bar, to prevent rotation,

while the pivot pin takes the stress from pulling and buffing. The shape of the emergency knuckle is such that it will fit about 90 per cent. of the 80 or more kinds of M. C. B. couplers that are now in service, and it is intended to be carried in cabooses in order to replace broken parts and to avoid the pres-



The Gilman-Brown Emergency Knuckle.

ent difficulty of carrying a large number of different makes of knuckles for running repairs. This knuckle is rigid and is for use in taking the train to a repair point, where the right knuckle for permanent repairs may be obtained. It appears to have an important field.

It is manufactured and sold by the Railway Appliances Co., 680 Old Colony Building, Chicago, of which Mr. Geo. H. Sargent is Manager.

DART'S UNION COUPLING.

The union coupling patented and manufactured by E. M. Dart Manufacturing Company, Providence, R. I., is brought to our attention because of the good results given in the extremely severe service of steam and other piping about locomotives and cars. The casing of the union is fitted to receive seats of bronze which form a ball joint with which pipes may be connected and made tight, even when considerably out of line, and the metal used prevents corrosion, which insures durability. The joints of locomotive and car piping are subjected to a con-



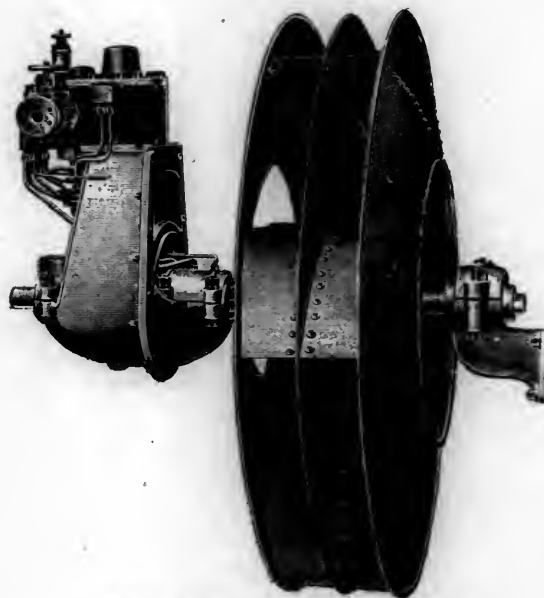
Dart's Union Coupling.

stant jar and vibration which tends to loosen ordinary unions and cause them to leak, but the reports from uses of this form indicate that it is very successful. They have now been in use for four years and we are informed that the Brooks Locomotive Works recently placed an order for 5,500 of them, in sizes varying from $\frac{1}{4}$ inch to 2 inches. They are also used by shipbuilders, smelters and miners, and a number have been sent out to the Chinese Eastern Railway, the device being adaptable wherever union couplings are used. Further information may be had from the manufacturers.

Locomotives on the Boston & Maine hauling passenger trains between Boston and Rockport, Mass., are using coke for fuel experimentally.

ENGINES AND FANS FOR THE BRITISH ADMIRALTY.

The accompanying illustration, taken from "The Engineer," shows one of the latest types of forced-draught steam fans, made for the British Admiralty by Messrs. Gwynne & Co., of London. The fans, which are open, of the double-breasted type, are built of steel, and are designed to combine the greatest strength with lowest possible weight. The engines, which are very compact, are of strong construction, being suitable for running when desired with a steam pressure of 300 lbs. per square inch, and also capable of performing full duty at 200 lbs. pressure. Their normal speed is 500 revolutions per min-



Engine and Fan, British Admiralty.

ute. The crank shafts are of best steel, cut out of the solid, the connecting-rods and eccentric-rods of the highest grade of manganese bronze, and all the bearings and working surfaces are of exceptionally large proportions, to minimize wear under the trying tests of high speeds and pressures to which these engines are subjected in work. The ends of the fan spindles opposite to the engines are carried in bearings of special construction, having a universal adjustable provision to prevent strain of the spindles should the true alignment be disturbed from any cause. Every precaution has been taken to insure continuous lubrication of all the moving parts while the engines are running.

BOOKS AND PAMPHLETS.

Steam Boiler Practice in Its Relation to Fuels and Their Combustion. By Walter B. Snow. 297 pages; illustrated. New York: John Wiley & Sons, 1899. Price \$3.

This book will be in demand among engineers, users of steam boilers and students. It has a field of its own, which is high praise for a book on boilers in these days. Its mission is to show the results of different methods of using boilers, rather than to treat the causes, and the appliances used. The work throughout testifies to the wide range of the author's investigation and research, and this is specially evident in the portions devoted to fuel and combustion. The author presents his subjects in a simple and clear style and refers the reader to a large number of authorities for more exhaustive investigation. The effect of the book is to stimulate study on the part of the reader, whether he is responsible for the working of steam plants or not, and it is made perfectly evident that careful attention to methods of operation are quite as important in steam boiler practice as the employment of expert advisors in the planning and construction. It is equally clear that the installation expense of a plant may be increased slightly with great advantage in the direction of draft appliances.

The book is divided into chapters, as follows: Steam Boiler

Practice; Water and Steam; Combustion; Fuels; Efficiency of Fuels; Efficiency of Steam Boilers; Rate of Combustion; Draft; Chimney Draft and Mechanical Draft.

The work abounds in valuable and carefully selected tables, and the author presents his own conclusions, drawn from the experience and published records of the best experimenters. The author has made a special study of draft and its effects upon combustion, and the book leads up to and includes an admirable presentation of the advantages of mechanical over chimney draft, Mr. Snow being a recognized authority on this subject. The study of the use of fuel, as covered by this book, is exceedingly important for every engineer and user of steam power, especially in view of the possibilities of making use of the cheaper grades of coal. Mr. Snow shows how to save a great deal of money by moderate expenditures for plant and the use of methods which are necessary for the burning of difficult fuels. One cannot read the book without becoming impressed with the importance of the subject, which is not generally appreciated. In connection with mechanical draft, a good discussion of the theory of fans is given, much of this part of the book having been prepared by the author last year and published in book form by the B. F. Sturtevant Co., under the title, "Mechanical Draft."

The present work should be consulted in connection with the design of new steam plants, and also in rearranging and enlarging old ones. The mechanical officers of railroads will find it particularly profitable.

University of Georgia. The Engineering Society Annual 1899 Volume IV. Chas. Morton Strahan, Editor in Chief, Athens, Ga.

Among the articles in this pamphlet are the following: Some Points on Lightning Protection, A. H. Patterson; Street Cleaning in Our Large Cities, J. H. McIntosh; On the Rotary Field, C. R. Andrews; Sewage Disposal, E. P. Shannon; Tall Buildings, K. Lindsey; Liquid Air, J. M. Brockman; Suggested Improvement in the Athens Filtering System, E. Lyndon and C. M. Strahan; Electricity on War Vessels, D. J. D. Myers; Drawings in the University Curricula, E. L. Griggs; The Electrical Department and Its New Equipment, U. H. Davenport; Tests of Vitrified Brick, J. W. Barnett, C. E.

The Standard Steel Works, Harrison Building, Philadelphia, Pa., have issued a catalogue of steel tires and steel tired wheels, a copy of which we are glad to receive. It contains engravings of the works, the machinery employed and the processes of wheel and tire making. In addition to these features the book contains chemical and physical requirements of tires for American, English, Russian, Japanese and Finland railroads. The tires furnished without special specifications are made to the following proportions, which are considered after service experience to be adaptable to railroads in all parts of the world: Carbon, 0.65 to 0.75 per cent.; phosphorus, below 0.05; silicon, below 0.25; manganese, 0.50, 0.70; sulphur, below 0.05; tensile strength, 110,000 to 125,000 lbs.; elastic limit, 55,000 to 65,000 lbs., and elongation in two inches 15 to 25 per cent. This company manufactures tires for driving wheels and car wheels, steel tired wheels with forged wrought-iron centers, also with cast-iron and forged cast-steel centers; steel castings for locomotives, including locomotive frames, and steel or iron forgings for railroad purposes. The annual capacity for locomotive tires is 20,000, and for wheels 15,000. An impressive story is told in half-tone engravings showing the large amount of material scrapped from the top ends of ingots and the effect of this practice on the finished product is exhibited in prints from etched sections of driving wheel tires, showing the porous condition of a tire in which some of the spongy top of an ingot was used instead of being returned to the furnace for remelting. The practice of these works is to cast long ingots, which are cut in four pieces, the top one being discarded. The catalogue also includes illustrations of tire fastenings and information which should accompany orders for wheels.

The Bullock Electric Manufacturing Co., Cincinnati, O., General Catalogue No. 24.—By aid of excellent half-tone engravings this catalogue describes the electrical equipment manufactured by this firm. After detailed descriptions of the generators and motors, a number of direct connected generating sets are illustrated, after which the application of electric motors to printing presses and to the direct driving of machine tools

are shown. This company has been in business for 10 years, being formerly known as the Card Electric Motor & Dynamo Company. An excellent and instructive example of electric driving is seen at their works in Cincinnati, as illustrated on page 225 of our July issue. In general design the Bullock machines are graceful in appearance, compact and strong. Circular field frames are used and the laminated pole pieces are cast into them. The field coils are machine formed, the shunt and series coils being wound separately and made independent of each other to permit of proper ventilation. The testing at the factory includes successful running of every motor for a considerable period. The brush holders are of the radial reaction, carbon type, one of the features of the operation being noiseless and sparkless running. The armatures are built up of thin charcoal-iron discs with radial air ducts at intervals throughout the body, through which the air is forced by the rotation of the armature. Maple wedges, placed in recesses, protect the armature coils from external injury. The commutators are built up of drop forged Lake Superior copper. The motors are in general identical with the generators except that the fields are shunt wound instead of compound. They are said to be sparkless under any change of load within their capacity. Motors of Type E are shunt or series wound of the multipolar design and are made specially for direct connection to machine tools, printing presses and other machinery. They may be placed on the floor, bolted to the ceiling, or secured direct to the base plates of machines to be driven. Slow speed motors of this type, when attached direct to a machine tool, permit of doing away with belts and make it possible to save the constant friction load of long lines of shafting. These motors may be directly connected to the line shafts, as in the case of the shops of the Mergenthaler Linotype Co., Brooklyn, where they are run at 180 revolutions per minute, the subdivision being into motors of 10 horse power. The operating devices are simple. They give a "slow motion" and 21 speed adjustments. For machine tool driving Type E multipolar slow speed motors, running at 360 revolutions per minute, are used. One of these is shown in the catalogue, driving a 72-inch planer. Other illustrations show a motor driven lathe in operation at the plant of Joseph Adamson & Co., Hyde, England. In other illustrations motors are connected directly, without belts, to a shaper, a punch, a railroad shop wheel press using hydraulic pressure up to 100,000 pounds per square inch, and to an upright drill press.

The Janney Coupler.—The McConway & Torley Co., manufacturers of the Janney coupler have issued one of the finest and most satisfactory catalogues that we have ever received. It contains illustrations and lists of parts of the various forms of Janney equipments for passenger cars, freight cars and locomotives, not only the most recently improved developments in the automatic appliances of these manufacturers, but also the earlier combinations, and is therefore a guide for ordering repair parts of equipments which have been in service for a number of years, as well as those having the most recent improvements. The text and tabular matter is all given on the left hand pages of the book and each right hand page is a plate containing the engravings shown in great detail. The engravings throughout are wood cuts of the clearest description, and those of the combinations, such as the passenger and freight equipment assembled in position, are remarkable examples of clear engraving, the like of which is very seldom seen anywhere. The specialties of the McConway & Torley Company are all shown, including the Buhop improvements, and it is unnecessary to mention them in detail. Every individual part of the equipment is numbered in the catalogue and these are all grouped in an index of details. The book concludes with a general index giving the index number of all the parts and the page number in the catalogue on which they may be found. The book is standard size, 9 by 12, bound in boards and is printed on wood-cut paper.

Brazing by Immersion.—The Joseph Dixon Crucible Co. have issued a pamphlet with the above title, reprinted from "The Cycle Age." It is the most complete article on modern methods of brazing and the apparatus used that has come to our attention. It describes the brazing crucible manufactured by the Joseph Dixon Crucible Co., for liquid brazing, which was illustrated in the "American Engineer," January, 1898, page 25.

The Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa., has added five numbers to its series of catalogues in pamphlet form. The subjects are: Transformer fuse blocks, Shallenberger integrating watt-meters, No. 38-B railway motors, generators and rotary converters for electrolytic work, and belt driven railway generators. The pamphlets are admirably gotten up. The descriptions are brief and to the point and the engravings show the views of the apparatus, which purchasers will want to see. They also contain dimensioned drawings and directions for ordering. These pamphlets are numbered and dated. The separate pamphlet plan is well adapted to the purpose of keeping information up to date in a line of work that is undergoing constant change and improvement.

A TESTIMONIAL TO MR. JOHN W. CLOUD.

The friendly feeling of the Master Car Builders' and the Master Mechanics' Associations to the retiring secretary, Mr. John W. Cloud, found expression at the recent conventions in complimentary resolutions passed by both organizations. These resolutions have been supplemented by a handsome testimonial in the form of a Jurgesen watch, valued at \$400, bearing the following engraved inscription: "Presented to John W. Cloud by his friends of the Master Car Builders' Association and the American Railway Master Mechanics' Association, June 21, 1899." The idea was suggested by Mr. C. A. Schroyer, President of the Master Car Builders' Association, and Mr. J. H. McConnell, President of the Master Mechanics' Association. Mr. Cloud responded in a letter expressing his thorough appreciation of the feeling toward him which prompted such a generous and cordial remembrance.

EQUIPMENT AND MANUFACTURING NOTES.

Orders for seven Baldwin-Westinghouse electric locomotives have been placed by the Imperial Government Railways of Japan for use in the Government and other mines in Japan.

The Atlantic Brass Co. of New York has opened an office in Room 1200, Fisher Building, Chicago, in charge of Mr. A. R. Perry as Western agent.

Laughlin & Company have ordered twenty-five 100,000-lb. capacity steel hopper cars of the Pressed Steel Car Co. The cars will be of practically the same type as the new cars for the Lake Shore.

Chicago Rabbeted Grain Doors will be used on 500 box cars for the Illinois Central, the contract for building having been made with the American Car & Foundry Company, St. Louis, Mo.

The Pressed Steel Car Company is reported to have closed a contract with the Carnegie Steel Co., Ltd., for \$6,000,000 worth of steel plates per year for ten years. It is said to be one of the largest contracts ever made in this country.

The Pennsylvania has just completed three Class PK passenger coaches at the Altoona shops. They have the Linstrom brake arrangement, automatic window hoists, Wheeler & Wilson seats and are to be used in fast train service.

The Chicago & Northwestern Railway has ordered 32 freight locomotives of the ten-wheel type, known as Class R, with 20 by 26 inch cylinders, from the Schenectady Locomotive Works. There are about 40 engines of this class now in service on this road.

The Modoc Soap Company, manufacturers of the Modoc Liquid Car Cleaner and Modoc Powdered Soap, are rapidly extending their trade and during the past few weeks have received orders from Africa, China, England and Nova Scotia in addition to the orders from railroads in the United States.

Since July 4 the Pressed Steel Car Company has delivered 168 cars to the Pittsburgh & Lake Erie Railroad, 40 to the Lake

Terminal Railroad, operated by the Lorain Steel Company, and 119 on a large order received from the Oregon Short Line.

Fast Mail train No. 8 on the Chicago, Burlington & Quincy Railroad left Mendota, Ill., on June 28, forty minutes late, and ran to Riverside, a distance of 72 miles, in 62 minutes, or at the rate of 69.67 miles per hour. The train was hauled by one of the class "P" Baldwin locomotives, No. 1,591, which was illustrated in our issue of May, 1899, page 141.

The Baldwin Locomotive Works have received orders for 13 consolidation locomotives from the State Railways of Finland for delivery before the close of this year. Forty locomotives have been shipped to the Chinese Eastern, and before the end of the year 31 more are to be built. The second installment of 10 engines for the Midland Railway of England has been shipped and we are informed that 10 locomotives for the State Railway of France are to leave for Bordeaux within a few days.

The Philadelphia & Reading have prepared plans for new shops at Reading. It is stated that the improvements will cost \$500,000, although the details of the undertaking have not yet been concluded. Despatches from Reading state that the main building of the new plant will be 300 by 700 feet. It is probable that the present shops will be leased to a manufacturing concern.

The Peerless Rubber Manufacturing Co., 16 Warren St., New York, have issued a folder in colors designed to attract attention to the merits of rainbow packing and other specialties of their manufacture for use in steam pipe, hydraulic and ammonia apparatus joints. The folder contains a caution against substitutes of rainbow packing fraudulently offered by some dealers, and offers a reward for information concerning such transactions. Mr. C. H. Dale, president of the company, evidently intends to protect patrons against imposition.

The business done by the Chicago Pneumatic Tool Company during the month of June has been the largest in its history, over five hundred orders for pneumatic tools of various kinds being booked. Their shipments included a large number of tools for Europe, one large order to the South African Republic and one to Australia. The factory of the National Pneumatic Tool Company of Philadelphia, the control of which has recently been acquired by this company, is running to its fullest capacity both day and night, as is also the case with the St. Louis factory, it being necessary to do this to keep pace with the orders.

The New York Blower Company, of which Mr. DeWitt T. Lyons is General Manager and Mr. Walter G. Holmes General Superintendent, have offices at 39-41 Cortlandt St., New York. The Boston Blower Company recently changed hands and these gentlemen, formerly connected with that firm, have associated themselves with the New York concern, whose works are in Louisville, Ohio. New machinery and skilled men have been assembled there under the supervision of Mr. Holmes, who was formerly superintendent of the Boston concern. The president of the New York Blower Company is Mr. R. C. Penfield. Information and prices for blowers, exhausters, heaters and engines may be obtained from the New York office.

The Electric Axle Light & Power Co. was incorporated at Trenton, N. J., on July 8, with an authorized capital of \$25,000,000, for the purpose of "lighting, heating, ventilating and refrigerating" railroad cars by means of electric currents generated from the revolutions of the car axle. The company has absorbed the National Electric Car Lighting Co. of New York, Mr. Max E. Schmidt, President, which controls the Moskowitz axle light in use on 100 cars on the Atchison and on a number of cars on other roads. The National Company was incorporated in 1894 and has had outstanding \$2,000,000 of common stock and in January last proposed to issue \$500,000 preferred. The new enterprise is backed by Isaac L. Rice and others identified with the Electric Storage Battery Co. The entire stock is to be paid for, and will be issued without bonus or commission of any kind.

The Curtain Supply Company has purchased the entire business, patents and machinery of the curtain and curtain fixture departments of the Adams & Westlake Company, of Chicago; the E. T. Burrowes Company, of Portland, Maine; and Forsyth Brothers Company, of Chicago, and the curtain and curtain fixture situation is now entirely cleared of the annoyance due to patent litigation. The plant of the new company is well equipped with modern machinery, and prompt filling of orders is promised. The factory and general offices occupy a large area at 85 to 93 Ohio Street, Chicago, and the disposition of the business appears to be a very satisfactory one. Mr. A. L. Whipple is the traveling representative of the company, and his wide acquaintance and his dignified, business like methods will be very valuable to the concern. The officers are Mr. E. T. Burrowes, President; Mr. W. W. Willits, Vice-President, and Mr. W. H. Forsyth, Secretary and General Manager.

The Bullock Electric Manufacturing Co. have a growing list of patrons, which is gratifying from a business point of view, and it is also an indication of the appreciation of the advantages of electric distribution of power in manufacturing and printing establishments. During the month of June just passed orders were received for 27 generators with an aggregate of 950 kilowatts capacity and 79 motors aggregating 1,050 horse power, many of the orders being for extensions of existing equipments, while others are for new outfits complete. Electric distribution is now indispensable in a large printing establishment and there are five prominent publishing concerns in this list, such as the "Hartford Times" of Hartford, Conn.; The Butterick Publishing Co., New York; R. Hoe & Co., New York; "The Nottingham Guardian," Nottingham, England; The Lawrence Publishing Co., Cleveland, Ohio, and the "Birmingham Daily Post," Birmingham, England. All of these orders were for complete printing press equipments. Among the other orders, several were from electric railways, one from the United States Government for the Mint at New Orleans, one from the Forbes Lithograph Co., Chelsea, Mass., and E. R. Durkee & Co., of New York. The last mentioned firm already has 26 Bullock motors in operation. The exhibit gives the best of evidence that manufacturers and others are awakening to the necessity for improved methods of shop operation. In selecting the Bullock machinery they have the advantage of dealing with a concern which has a reputation for reliability and skill. This company is far advanced in the application of motors direct connected to machine tools. Their catalogue No. 24 is worth sending for.

The Union Boiler Tube Cleaner Company of 253 Penn Ave., Pittsburgh, Pa., was organized in 1895 for the purpose of introducing an entirely new industry, that of removing scale from the interiors of the tubes of water tube boilers. It is to-day the only concern of the kind in the world having machinery especially designed for their specific business, patented abroad as well as in this country, by which they are enabled to contract for thoroughly cleaning boilers under a time limit with bond for heavy penalty for non-fulfillment or to sell or lease tools for cleaning all makes of water tube boilers having straight horizontally inclined or vertical tubes and those having curved tubes, such as the Climax and Stirling boilers; also the Hazelton, having closed end tubes; the latter three types being heretofore considered, and without these devices are yet, impossible to clean. They commenced business as a firm May 1, 1895, a time of the greatest depression in industries in the history of the country, notwithstanding which the great merits of their devices caused their immediate adoption by some of the largest concerns in the United States and England. Their value as a fuel saving device as well as one that increases the efficiency of boilers even when practically new, if not entirely so, was such as to call forth high praise from users and such is the continued demand that notwithstanding the fact that the manufacturers started with a well equipped factory, they are constantly enlarging their works, putting in additional machinery, and have more than doubled their force of workmen since the first of the year in endeavoring to keep up with orders. The device makes use of a flexible shaft which is unique in its way, having been compelled to design one to enable them to clean boilers having curved or other tubes inaccessible for a stiff rod, owing to the fact that other shafts would not stand the wear and tear under great stress.

In the last week in June, 1899, the Pressed Steel Car Company delivered 205 100,000-lb. capacity steel hopper cars to the Pittsburgh & Lake Erie Railroad Company, and 17 on an order for 1,000, to the Lake Shore & Michigan Southern. In addition 100 carloads of trucks, bolsters, center-plates, etc., were shipped to various railroad companies. The total valuation of shipments for the week exceeded \$368,000. The sales for the month of June, 1899, aggregated \$1,250,000. Exclusive of the steel cars, the total weight of the manufactured material delivered, June 24th to 30th, inclusive, was 4,397,405 lbs. Since December 13th, last year, 12,598 steel cars have been ordered of the Pressed Steel Car Company for delivery this year, of which nearly one-half has been delivered. The Pennsylvania Railroad, B. & O., B. & O. S. W., Lehigh Valley, Philadelphia & Reading, P. B. & L. E., Oregon Short Line, Union Pacific, L. S. & N. S., P. & L. E., L. S. & I., Great Northern and Egyptian State Railways are roads which have ordered heavily. Cars were ordered the first six months of the year at the rate of \$25,000,000 per year.

MASTER CAR BUILDERS' ASSOCIATION REPORTS.—CONCLUDED.

Brake Shoe Tests.

Committee—S. P. Bush, R. P. C. Sanderson, Geo. Gibbs.

At the last convention of the Association it will be remembered that this committee reported that arrangements had been made for the transfer of the brake shoe testing apparatus to Purdue University, where it was to be properly cared for by the University and protected from loss by insurance, under a written agreement presented for file with the Secretary of the Association. Your committee this year would state that the transfer of the testing apparatus had been effected, and that it is now in operation at Purdue University. Purdue University is using it for instructive purposes, and they will also be glad to make tests for any manufacturers that may wish to have tests made, upon the payment of a nominal fee which will cover the expense that the University may be put to.

Since the original tests made by the committee there has been considerable activity in the way of developing brake shoes to produce greater efficiency, with the view particularly of obtaining greater durability of brake shoes in service. This effort has been in the direction of composite, or composition shoes, and while greater durability is very much desired, it is also important to the railways in general that durability should not be obtained at the sacrifice of proper braking power. There are perhaps three or four shoes being produced to-day which it might be well for the Association to have tested under the direction of its committee, with the view of determining their frictional values, comparing them with the original tests of hard and soft cast iron, and your committee would recommend that it be instructed to test such brake shoes as may be presented to it for that purpose and which may seem to have made sufficient departure from those previously tested to have effected their efficiency or durability.

MASTER MECHANICS' ASSOCIATION REPORTS.—CONCLUDED.

Flanged Tires.

Committee.—S. Higgins, W. Garstang, W. H. Thomas.

The desirability of using flanged tires on all the driving wheels of mogul, ten-wheel and consolidation engines depends on certain conditions which have to be taken into consideration, and these conditions are as follows: 1. Length of rigid wheel base; 2. Length of total wheel base; 3. Are rigid or swing-motion engine trucks used?; 4. Lateral motion between driving box and hub when engine leaves shop?; 5. Lateral motion between engine truck box and hub, when engines leave shop; 6. Degree of curvature on line where engines are to be operated; 7. Practice of roadway department as to the gauge used on curves.

A summary of the information (from roads owning a total of 12,265 locomotives) received in reply to the circular is as follows:

	All Flanged.	1 and 3 Flanged.	2 and 3 Flanged.	1 and 4 Flanged.	1.3 and 4 Flanged.	Total.
Mogul	440	743	....	....	....	1,183
Ten-wheel	534	1,048	702	....	....	2,284
Consolidation ..	348	....	....	1,313	405	2,066
Total	1,322	1,791	702	1,313	405	5,532

	—Longest rigid wheel base—		—Longest total wheel base—	
	All Flanged.	Partly Flanged.	All Flanged.	Partly Flanged.
Mogul.....	16 ft. 1 1/4 in.	16 ft.	23 ft.	23 ft. 10 1/4 in.
Ten-wheel....	14 ft. 4 in.	16 ft.	24 ft. 10 in.	26 ft. 6 in.
Consolidation.	16 ft. 3 in.	16 ft. 3 in.	24 ft. 2 in.	24 ft. 6 in.

A swing motion engine truck is used with the three types of engines having all tires flanged, the motion being 1 1/4 inches each side of center. The same practice prevails with mogul, consolidation and many ten-wheel engines having tires

what is known as the Briggs standard wrought iron pipe threads, a copy of which is included in the report.

As a result of the examination of the samples submitted, it was found that the variations from the original standard were such as to warrant the conclusion that the Briggs standard should be maintained. With the exception of the $\frac{3}{4}$ -inch and 1-inch sizes, comparatively little change would be required in any of the dies to accomplish this.

At a meeting of the Manufacturers of Wrought Iron Pipe and Boiler Tubes in the United States, held in Pittsburgh, November 4, 1886, the Briggs standard was endorsed, and also by the Manufacturers' Association of Brass and Iron, Steam, Gas and Water Work, December 15, 1886.

In view of what has preceded, it seems to be well established that it was the intention to adopt the Briggs standard of threads for wrought iron pipes and fittings.

Notwithstanding the action taken, as outlined above, recent investigations made by your committee disclose the fact that so far as the $\frac{3}{4}$ -inch and 1-inch sizes of pipes are concerned, certain manufacturers are still adhering to the standards they had in use in 1886. The variation from the Briggs standard in these sizes of pipes is due to the fact that some makers use a thicker wall by using a larger outside diameter than called for by the Briggs tables, this difference averaging about .03 of an inch. As a consequence the couplings of these thicker pipes are somewhat large for pipes made in accordance with The Pratt & Whitney Briggs standard, and the pipes themselves somewhat large for the couplings made to the Briggs standard.

From the answers received to the circular letter we draw the conclusion that very little trouble is experienced because of lack of uniformity in the threads of wrought iron pipes and couplings; that there is a general understanding that the Briggs table of threads and dimensions is the adopted standard. Out of about sixty replies to this circular we find but eight roads which specify by what templates the Briggs standard shall be tested, and of these eight, six specify The Pratt & Whitney Co. templates. In view of the foregoing facts we recommend the adoption of the Briggs standard, as determined by The Pratt & Whitney Co. gauges, as the standard threads for wrought iron pipe and couplings.

So far as we have been able to determine, there is no universal standard for the threads of wrought iron pipe union nuts, though the sleeves of the unions are quite generally threaded in accordance with the Briggs standard. Because of the great number of standards used by the different manufacturers, the numbers of changes made in the chairmen of the committees, the lack of promptness in receiving promised samples, and several other causes producing unavoidable delays, we are unable to make any recommendation concerning standard threads for wrought iron pipe unions at present. We believe it would be wise if such a general standard could be adopted and would recommend that this portion of the work be continued.

Best Method of Applying Stay Bolts to Locomotive Boilers.

Committee.—T. A. Lawes, G. F. Wilson, S. M. Vauclain.

The general practice is to cut stay bolts off to the required length by a concave cutter in a shearing machine. The Pennsylvania Company cuts them off in a turret lathe. The C. C. & St. L. Ry. uses a device in which the bolt is held more firmly, while being sheared, than in the ordinary concave shears, and it cuts the ends off squarely. When the concave cutter is used there is more or less tendency for the stay bolt to raise while the shear is cutting, and the result is the end is not cut off squarely.

The usual method of making square heads is by the use of a bolt header. The Buffalo & Susquehanna R.R. makes them with dies under a steam hammer; the Chicago, Burlington & Quincy R.R. mills off square at end of stay bolt; the Chicago & Northwestern Ry. makes the square with a punch under shears; the C. C. & St. L. Ry. does the same, with a special device. Heads can be put on with this device by one man at the rate of 300 per hour. An ordinary bolt header can do this work at the rate of 300 per hour, requiring, however, one man and a helper to operate it. Several members report that they do not square ends. The Chicago & Eastern Illinois R.R. has tried headless bolts, but has abandoned their use, for the reason that after screwing them in with an air motor an adjustment must be made by the use of an alligator wrench in order to move the bolt just far enough to properly rivet it. The time used in adjusting and removing the alligator wrench more than balances the cost of forging the square ends.

The Chicago, Milwaukee & St. Paul Ry. report the use of a six-spindle cutting machine—running the bolts through twice; the first time roughing them down very nearly to size and the second time with dies that are in perfect condition—only requiring to straighten up, and cutting but little additional thread. The Delaware & Hudson Canal Company also take two cuts on stay bolts—the second cut being a very light one to finish. A better thread can be obtained by this method, though the usual practice is to take but one cut over a stay bolt. A number of roads report the use of a lead screw attachment an essential to produce stay bolts with threads of accurate pitch.

A large number of roads report the use of ordinary stay bolt taps. A number, however, claim advantages in the use of the "Echols" patent stay bolt tap made by Pratt & Whitney. The principle of this tap is the omission of each alternate tooth; each cutting tooth is followed by a space which gives a freedom

of action to the cutting teeth, impossible in the old style, thus decreasing the resistance from 30 to 50 per cent.

In making and applying stay bolts to locomotive boilers, two important factors must be carefully considered: The stay bolt tap and the hob tap which cuts the dies in bolt-cutting machine must be true to pitch, and then the machine must have some special device for making the threads true to pitch. Cutting stay bolts true to pitch is a subject that deserves more investigation, we think, than any other detail connected with making and applying them properly. The weak point in a great many shops is in cutting stay bolts untrue to pitch. It has been found that accurately pitched dies will not produce true-pitched bolts.

Pratt & Whitney write the committee that "the problem of making a tap with long thread and keeping that thread to approximately correct lead has been a very annoying one to us, and doubtless to others, and is still annoying, for the very reason that we cannot rely upon the extent to which steel will change and the manner in which the change will take place. We overcome this very largely, however, by having carefully annealed steel to begin with; having the annealing as uniform as possible, and threading the tap with a screw which is made expressly for the work, and which has an error approximately the error which takes place in the tap in the hardening operation; i. e., long experience teaches us that steel will change in a certain direction. In the great majority of cases this direction is toward the shortening rather than the lengthening. We accordingly make the lead screw of our lathe long, as stated above, to compensate for the shrinkage or shortening that will take place in the steel when hardening. We very often have to give the tool a double shrinkage in very special cases. What we mean by double shrinkage is hardening the tool and re-annealing before the final finish, threading on all important taps that have any special length of thread. We confine the error to .0015 per inch or .18 inch per foot."

Correctly cut dies alone will not cut true-pitch stay bolts; to insure stay bolts being cut true to pitch, two methods have been employed: A lead screw attached to the carriage of a bolt-cutter is one way to accomplish this, and the lead-controlling feature employed by the Jones & Lamson Machine Company in the dies used in flat-turret lathe made by them the other.

The Acme Machinery Company writes the committee as follows: "All dies that we have any knowledge of gain threads and lose pitch when cutting threads. Some of our expert die-makers can grind a set of dies so that they can be made to do 'most anything,' but that does not help the 'rank and file,' into whose hands such a machine falls. All kinds of schemes and contrivances have been made and used in trying to correct the disposition of a set of dies to cut out of pitch. Supposing, for instance, the rear teeth of a set of dies would act as a nut; they would certainly begin with an error, because the leading teeth are apt to begin with more or less error, as they 'nibble' at the end of a bolt."

At the New York meeting of the American Society of Mechanical Engineers, in December, 1897, Mr. James Hartness, of Jones & Lamson Co., read a paper on a stay-bolt threading device which has some valuable features, especially for radial stays, where there are threads on both ends of stay bolts and long blank spaces between. (See American Engineer, April, 1898, page 122.) The committee has samples of screw-cutting done by the use of a lead screw on a bolt cutter, and also by the use of a Hartness die. Both methods give equally good results, so far as can be judged by the samples.

The investigations of the committee lead it to believe that the best method of making and applying stay bolts is as follows:

Cut the stay bolts from the bars by means of a shearing machine; make square ends by the use of a bolt-heading machine, or punching the metal from the bar to form a head; cut threads in a bolt cutter, having a lead screw, or on a turret machine having special dies that will cut true to pitch. For a cutting lubricant, lard oil is the best, with yellow cottonseed oil a close second. In preparing the stay-bolt holes, we recommend that: In the fire box, they should be drilled; in the shell of boiler, punched $\frac{1}{4}$ -inch smaller than required size and the remainder reamed out with a reamer on end of stay-bolt tap. Holes should be tapped with some form of air or electric motor, and stay bolts screwed in with same device. We also recommend that stay-bolt taps, and hob taps for cutting stay-bolt dies, be purchased from some reputable maker in preference to making them at a railroad shop. Stay-bolt and hob tap making requires special skill and most accurate tools, which are not always available at railroad shops. For cutting off stay bolts, no device appears to answer for all bolts. The best practice seems to be as follows: Where bolts are of uniform length, and are at right angles with sheets, as in vertical water space surrounding fire box, it is best to "nick" the bolts in a lathe to the right length; after being screwed into place a slight tap on the end is sufficient to break them off. For bolts that require to be cut off at an angle, an electric saw can be used to advantage; as in cutting or radial stay bolts, outside of boiler. A pneumatic cutting machine can be used to advantage for cutting off bolts of variable lengths after they have been screwed into place, where it would not pay to handle them singly in a lathe or cutting machine. The committee knows of no better way of riveting stay bolts than the well-known method with the common hammer, and a holding-on hammer at the other end of the stay bolt. It is the committee's opinion that some form of air motor for drilling the "detector" holes in stay bolts is preferable to punching them. The objections to punching detector holes is that while stay bolts are being riveted the holes close up and require to be opened with a drift. When the bolt is drilled after it has been riveted there is no further work to be done.

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CORRUGATED FIREBOX BOILER.

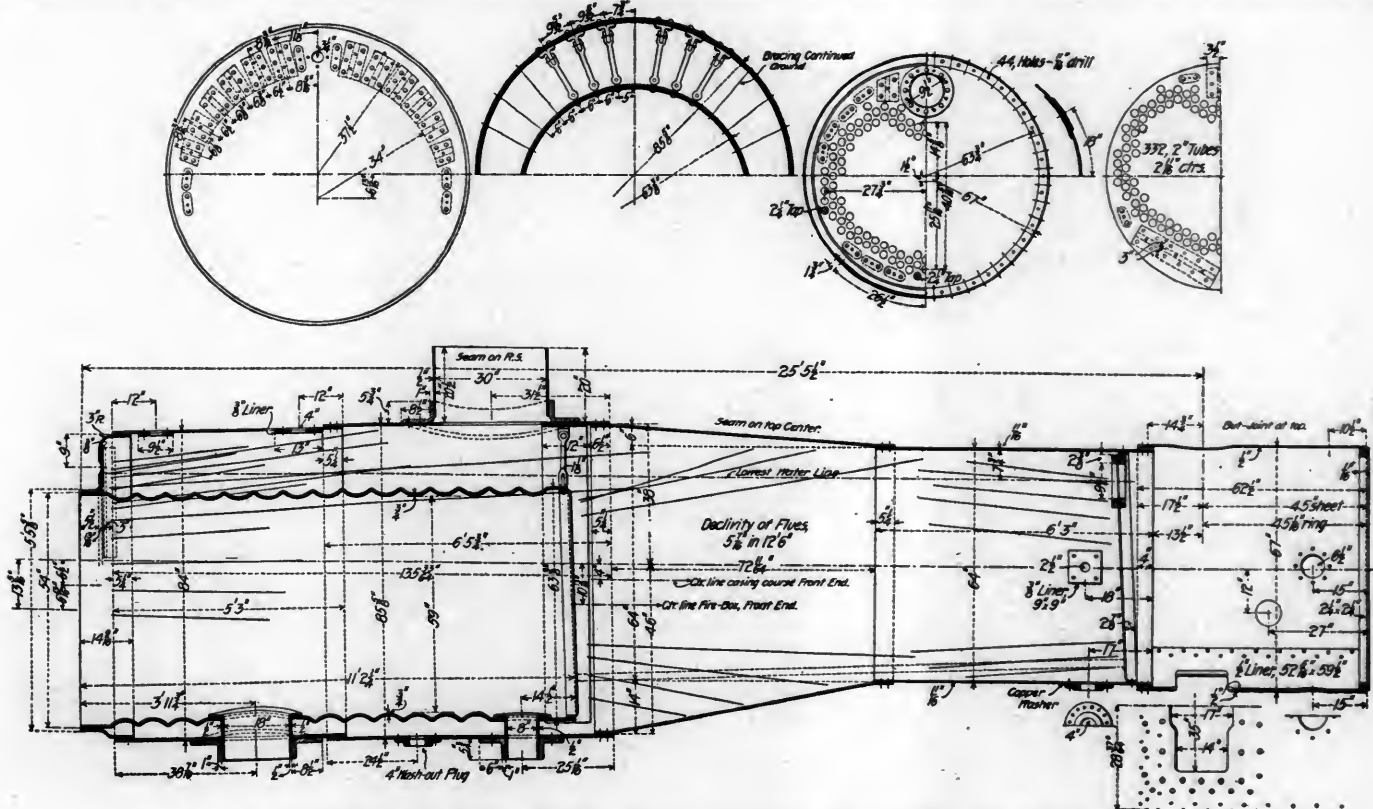
New York Central & Hudson River Railroad.

A corrugated firebox of the marine type, made by the Continental Iron Works of Brooklyn and well known as the Morison Suspension Furnace, has been applied to a ten-wheel freight locomotive of the New York Central & Hudson River R. R., according to drawings made by Mr. Cornelius Vanderbilt,

Jr. Several attempts have been made to use this type of furnace in locomotive practice, and while the idea is not new, this application is interesting, because of the opportunity for testing the merits of stayless fireboxes on a locomotive in such a way as will permit of making comparison with modern examples of the usual type. This boiler is somewhat like that of Lentz, which was described in the "Railroad and Engineering Journal," April, 1890, page 159. Pohlmeier also designed one of this kind, which was described in that journal, June, 1889, page 272. This new furnace is much larger than Lentz used and is very much larger than those used by Strong in his double firebox boiler, which is so well known and has proved to be very powerful.

The locomotive is the same in general dimensions as the one illustrated on page 255 of our August issue. The cylinders are the same and also the running gear, except the driving wheels, which are 61 inches in diameter in the one with the corrugated firebox. The weight on driving wheels is 113,000 lbs., and the weight on the truck is 44,700 lbs., making the total weight 160,000 lbs. The grate area is 34 square feet and the heating surface is 2,356 square feet, of which the tubes furnish 2,164 square feet. This grate area is due to the fact that this furnace is the largest that the manufacturers have ever rolled. The locomotive was built at the West Albany shops of the road. It was begun under the supervision of Mr. Wm. Buchanan, formerly Superintendent of Motive Power, and has just been finished.

The firebox diameter inside is 59 inches and its length is 11 feet 2¼ inches, its thickness being ¾ inch. It was tested at the works of the manufacturers with hydraulic pressure of 500 lbs. per square inch, applied externally, which caused a distortion of less than one sixth hundredth of an inch. The method of securing the firebox in place and the arrangements of the tube sheet and the back head are shown in Fig. 1. This view also shows the two flanged thimbles through the furnace. The front one is 8 inches in diameter, placed 14 inches from the front end, and the other, which is for the removal of ashes, is 18 inches in diameter and is located about 4 feet from the back head. The front thimble is covered by a hood somewhat re-



Experimental Corrugated Firebox Boiler Designed by Cornelius Vanderbilt, Jr.
New York Central & Hudson River Railroad.
Fig. 1.—Longitudinal and Transverse Sections.

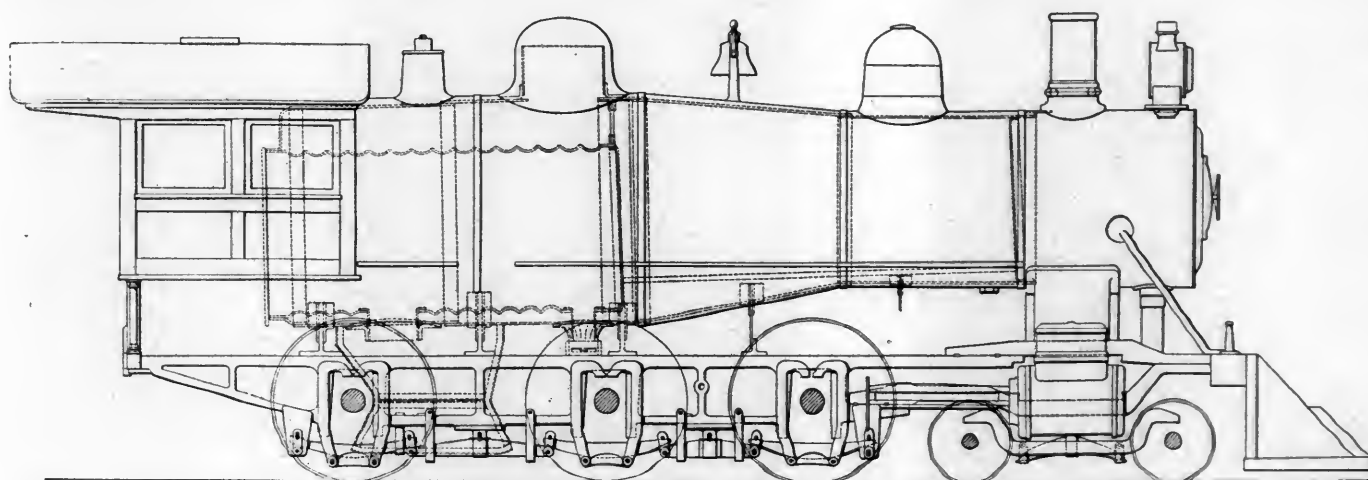


Fig. 3.—Corrugated Firebox Boiler.

New York Central & Hudson River Railroad.

made of properly selected lumber. Size has much to do with the cost, however, and for capacities of more than 100,000 gallons wood could not be used. Mr. Snow expects to see tanks made of large diameter and less height than are now customary. The increased cost of pumping into high-sided tanks is worthy of consideration, and the danger of freezing is less in tanks of larger diameter. Steel tanks appear to have gained popularity recently, but the present high price of steel is likely to increase the favorable opinion of wooden ones.

In discussing Mr. Snow's paper, Mr. Onward Bates, Superintendent of Bridges and Buildings of the Chicago, Milwaukee & St. Paul Railway, expressed his interest in the subject and stated that he had recently figured on installing some steel tanks, but was deterred by their high cost compared to wooden ones. His remarks were in part as follows:

"It is true that a wooden tank ought to last 20 years. I know of some wooden tanks which are at least 30 years old, and also of some which fell down as the result of trying to carry them too long.

"Failures which I have noticed were due to failure of the hoops, weakened by rusting, in some instances, and in other instances tanks fell down in consequence of rotten supports. I think Mr. Snow is right that a good wooden tank will last as long as two sets of hoops, and it is my practice to put additional hoops on all tanks that are getting old. My trouble has been with hoops rusting on the side next to the tank, and it is difficult to inspect such hoops, as the outside, when kept painted, may be reasonably free from corrosion, while they are nearly rusted through from the inside.

"The staves and bottom of a wooden tank will last indefinitely if the tank is kept full of water, but conditions are not so favorable in this respect as formerly. At many water stations the increased train service causes such a demand on the water supply that it is not possible to keep the tank full of water, and when this is the case, the upper ends of the staves soon show decay. I think a wooden tank should last twice as long as the wooden frame which carries it.

"The chief trouble in building wooden tanks is in getting good timber. We still use white pine, but this, if in any degree clear and free from sap and knots, is expensive. The kind of white pine we would like to use, that is, clear white pine, may run up in cost to \$40 a thousand. We do not spend, perhaps, more than \$16 per thousand for tank lumber.

"While wooden tanks are subject to decay, steel tanks are not free from corrosion. Railroads must of necessity use all kinds of water that is not at all usable, for in many localities

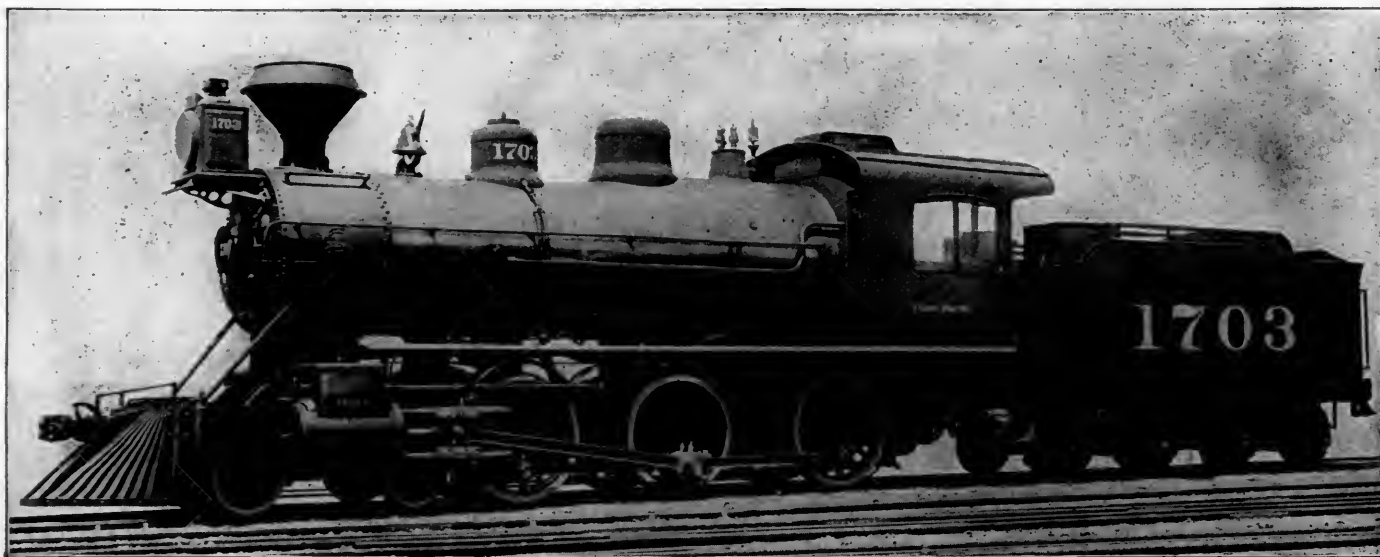
good water is not to be obtained, and the kind of water which penetrates 3-inch pine staves and eats up the hoops of a wooden tank must be severe on a steel tank. With such water I question if a steel tank will outlast a wooden one. The quantity of water to be supplied will determine the economical solution of the question of 'Wood vs. Steel Tanks,' and with growing demand for larger supplies more steel tanks will be used. These are already growing in favor on some of our railroads, and it will not be long before we have practical knowledge of their suitability for such service. We may also hope that the price of steel will again fall to where it will admit of competition with wood."

The train staff was the subject of a paper read by Mr. W. J. Murphy, superintendent of the C. N. O. & T. P. Railway, before the Central Association of Railroad Officers at the recent St. Louis meeting. He described the divided train staff as it is used on that road near Cincinnati. One-half of the staff is given to the engineer and the other half to the conductor. There are 31 staffs in the two instruments and one of these forms the key for unlocking the tablet box containing six permissive tablets; this feature, however, is not used for passenger trains and its use is always under the control and direction of the superintendent. A semaphore is used in connection with the staff to govern admission into the staff station, and the signaling circuits are controlled by the semaphore in such a way as to cut out the signal communication except when the signal is in the horizontal or stop position. A special form of dispatcher's order is used in case of failure of the staff apparatus. This is an absolute block order and gives rights over all other trains.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.

The thirtieth annual convention of the Master Car and Locomotive Painters' Association will be held at Philadelphia, Pa., on the 12th, 13th, 14th and 15th of September, 1899, convening at 10 o'clock A. M., on Tuesday, the 12th, at the Continental Hotel (located at Ninth and Chestnut streets, opposite the U. S. Government Building and Post Office), which has been chosen as the official headquarters of the Association.

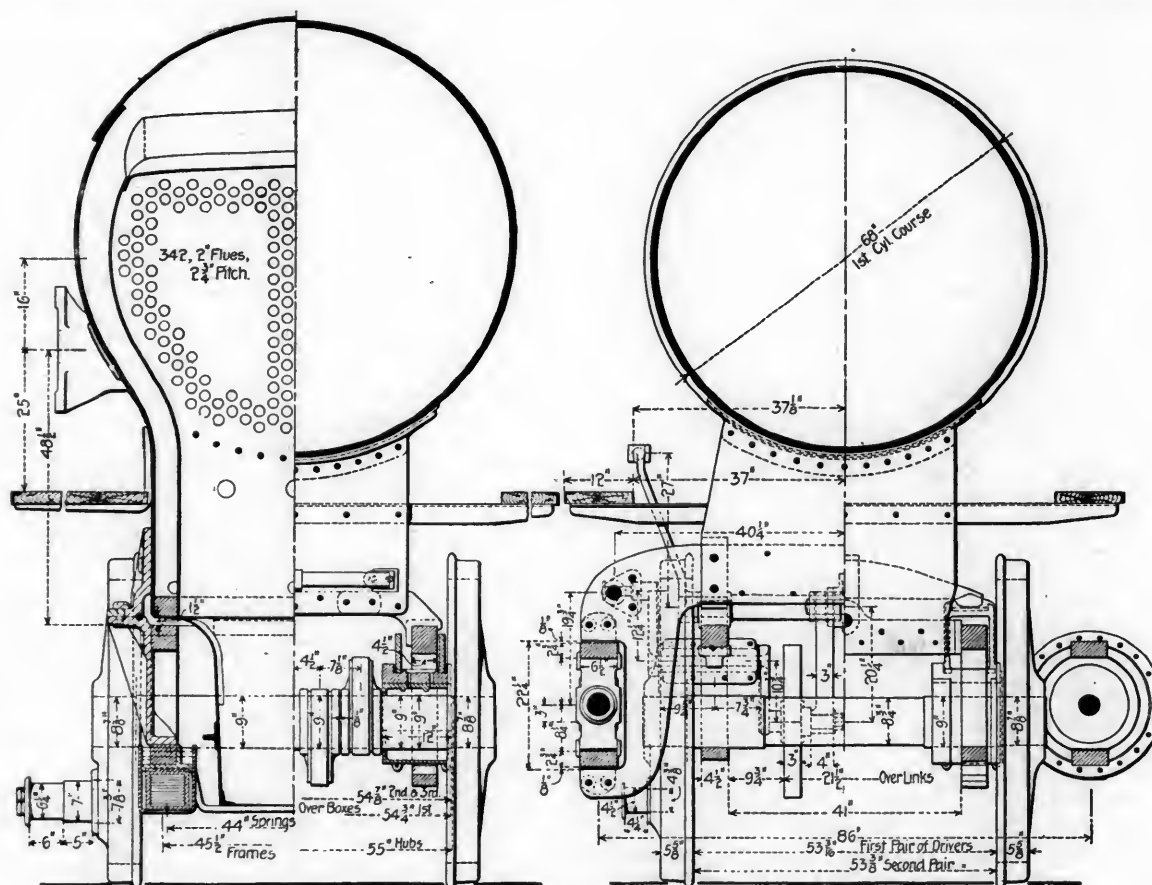
The Association extends a general invitation to all Foremen Car and Locomotive Painters in the States and Canada to meet with them in convention and participate in the discussions which will come forward during the session on many important questions in connection with Car and Locomotive Painting.



Ten-Wheel Freight Locomotive—Union Pacific Ry.

MR. J. H. McCONNELL, *Superintendent Motive Power.*

BROOKS LOCOMOTIVE WORKS, Builders.



Transverse Sections.

TEN-WHEEL FREIGHT LOCOMOTIVES.

Union Pacific Railway.

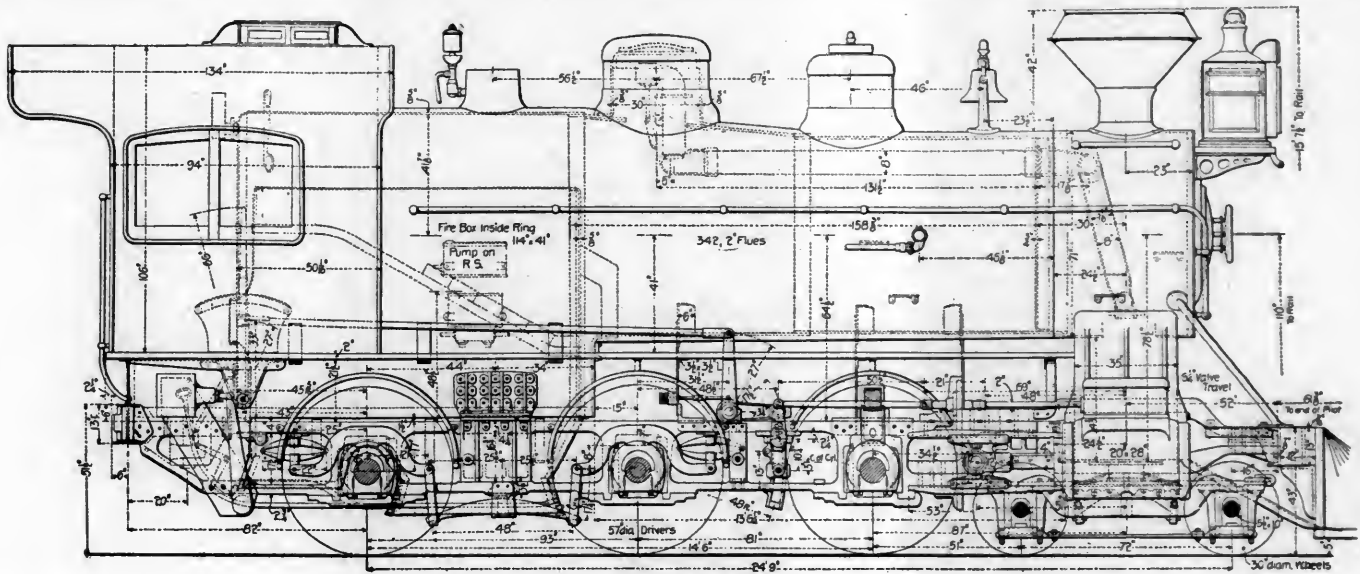
Brooks Locomotive Works, Builders.

Through the courtesy of Mr. J. H. McConnell, Superintendent Motive Power of the Union Pacific Railway and the Brooks Locomotive Works, we illustrate and describe one of forty ten-wheel freight locomotives which have just gone into service on that road.

The total weight of the engine is 170,000 pounds,

with 134,000 pounds on the driving wheels. The cylinders are 20 by 28 inches; the driving wheels 57 inches diameter, of cast steel; the driving journals are 9 by 12 inches; the boiler is of the crown bar type, the diameter of the barrel being 68 inches, and that of the back head 76¼ inches. The heating surface is 2,574 square feet, which, by the way, is only 67 square feet more than that of the 8-wheel passenger locomotive for the Chicago & North Western Railway (American Engineer, July, 1899, page 224). The firebox is 114 inches long by 41 inches wide, giving 31.3 square feet of grate area.

These locomotives have the diamond stack arranged on the



Longitudina Section.

plan shown in Fig. 16 of our May issue, page 161, this form being the standard practice of the Union Pacific. All of the driving wheels have flanged tires, this practice having been followed by Mr. McConnell for some time with satisfactory results. The crosshead is of the two-bar type. The spring rigging uses a 44-inch spring across the engine for the forward drivers, with a strong brace between the frames to support the fulcrum. The main and rear drivers are equalized by means of 48-inch springs placed below the frames, attached to curved levers passing over the driving boxes by means of links 17 inches long, and the frame connections are made through short elliptic springs. The cross section shows the arrangement of the valve gear, which is somewhat like that used by these builders for locomotives with piston valves, the rocker arms being upon the opposite ends of the rocker shafts, which are hollow. The main crank pins are enlarged where they enter the wheels, but those of the other driving wheels are reduced, as are also the wheel fits of the driving axles. The driver brakes are the American and the New York Air Brake Company's apparatus, including the air pump, are used for the engine, tender and train. These engines have Fox pressed steel tender trucks. The leading characteristics of the design are given in the following table:

GENERAL DIMENSIONS.

Description.	
Gauge	4 ft. 8½ in.
Kind of fuel to be used.	Bituminous coal
Weight on drivers	134,000 lbs.
Weight on trucks	36,000 lbs.
Weight, total	170,000 lbs.
Weight tender, loaded	110,000 lbs.

General Dimensions.

Wheel base, total, of engine	24 ft. 9 in.
Wheel base, driving	14 ft. 6 in.
Wheel base, total, engine and tender	52 ft. 4½ in.
Length over all, engine	38 ft. 6¼ in.
Length over all, total, engine and tender	62 ft. 9½ in.
Height, center of boiler above rails	9 ft. 2 in.
Height of stack above rails	15 ft. 7½ in.
Heating surface, firebox and arch flues	231 sq. ft.
Heating surface, tubes	2,343 sq. ft.
Heating surface, total	2,574 sq. ft.
Grate area	31.3 sq. ft.

Wheels and Journals.

Drivers, number	6
Drivers, diameter	57 in.
Drivers, material of centers	Cast steel
Truck wheel, diameter	30 in.
Journals, driving axle	9 in. x 12 in.
Journals, truck	5½ in. x 10 in.
Main crank pin, size	6¼ in. x 6 in.

Cylinders.

Cylinders	20 by 28 in.
Piston, stroke	28 in.
Piston rod, diameter	4 in.
Main rod, length, center to center	9 ft. 9 in.
Steam port, length	18½ in.
Steam ports, width	1½ in.
Exhaust ports, length	18½ in.
Exhaust ports, width	2½ in.
Bridge, width	1½ in.

Valves.

Valves, kind of	Allen-Richardson
Valves, greatest travel	6¼ in.
Valves, outside lap	1½ in.
Valves, inside lap	None
Lead in full gear	1/16 in. negative

Boiler.

Boiler, type of	Crown bar wagon top
Boiler, working steam pressure	200 lbs.
Boiler, thickness of material in barrel	¾ in.
Boiler, thickness of tube sheet	¾ in.
Boiler, diameter of barrel	68 in.
Dome, diameter	30 in.

Firebox.

Firebox, type	Over frames
Firebox, length	114 in.
Firebox, width	41 in.
Firebox, depth, front	79 in.
Firebox, depth, back	79 in.
Firebox, thickness of sheets	Tube, ¾ in.; sides, ¾ in.; top, ¾ in.; back, ¾ in.
Firebox, brick arch	On water tubes
Firebox, mud ring, width	4 in.
Firebox, water space at top	Back, 5 in.; sides, 6½ in.; front, 4 in.
Grates, kind of	Cast iron rocking
Tubes, number of	342
Tubes, material	Charcoal iron
Tubes, outside diameter	2 in.
Tubes, length over tube sheets	13 ft. 2¾ in.

Smokebox.

Smokebox, diameter, outside	71 in.
Smokebox, length from flue sheet	53 in.

Other Parts.

Exhaust nozzle, single or double	Double
Exhaust nozzle, diameter	3 9/16 in.
Exhaust nozzle, distance of tip below center of boiler	27½ in.
Netting, wire or plate	Wire, in top of stack
Netting, size of mesh or perforation	3 x 4
Stack, straight or taper	Diamond
Stack, diameter	16¼ in.
Stack, height above smokebox	42 in.

Tender.

Type	8-wheel, Wood frame
Tank, capacity for water	5,000 gal.
Tank, capacity for coal	12 tons
Type of under frame	Oak
Type of springs	Double elliptic
Diameter of wheels	33 in.
Diameter and length of journals	5 in. x 9 in.
Distance between centers of journals	5 ft. 3 in.
Diameter of wheel fit on axle	6½ in.
Diameter of center of axle	5½ in.
Length of tender over bumper beams	23 ft. 0 in.
Length of tank	20 ft. 0 in.
Width of tank	9 ft. 10 in.
Height of tank, not including collar	56 in.

A radical change is being made in the appearance of the baggage, mail and express cars on the Baltimore & Ohio Railroad. The platforms and hoods are being removed to increase the element of safety and save weight. The favorite riding place of tramps is also eliminated when the platforms are removed. General Manager Underwood has also issued an order to remove the numbers from locomotive tenders, so that in cases of emergency, those of the same style will be interchangeable.

CORRESPONDENCE.

SPEEDS OF FREIGHT TRAINS.

Editor "American Engineer":

I have read with great interest the article on page 206 in your June issue by Mr. Henderson, on Freight Traffic Economics, and consider it most valuable and timely, not only for the results arrived at but from the attention it draws to the danger of following too far the reasoning that demonstrates a continual decrease of expense with increase of tonnage and indicating a point at which increased tonnage leads to additional expense per ton mile. This question is, of course, independent of the principle of rating by tonnage as opposed to rating by cars, which has been certainly proven by far the more accurate measure of the hauling power required, and in consequence enabled higher average loads to be pulled at any desired speed. There is, however, very great probability that with the introduction of tonnage rating, train loads have on some roads been increased beyond the most economical point, especially so when business is heavy and the capacity of the power is taxed to handle it. These very heavy trains, dragging over the division, have been a source of far greater loss than saving, although the latter was expected.

Referring to Mr. Henderson's article, it appears to me that he has made his calculations in a manner that is rather less favorable to the higher speed than is actually the case, for the reason that he has omitted to make any allowance for the extra time that the cars are engaged in hauling one ton one mile at the lower speeds. This is certainly as important as the interest and depreciation allowed in the case of the engine and is at least necessary to represent the difference in the earning capacity per car if hauled at 5 or 15 miles per hour. As in the case of the locomotive, this is, in busy times, scarcely accounted for by 5 per cent. on the capital invested, but ideal cases must, of course, be assumed for purposes of argument, and, if all cars were considered loaded, the capital involved would approximate \$10 per gross ton, an amount comparable with the value of the engine and which would cheapen the relative cost of the higher speeds. The speeds above 10 miles per hour have been given an advantage in the case of many roads by the fact that the wages have been put on an hourly basis. If paid by miles when in excess of hours, these would not decrease per mile as the speed increased, and if paid by the trip the same thing would hold true.

On the whole the article appears to be a strong endorsement of the practice of not allowing tonnage to be hauled that necessitates an increase of time over ten miles per hour, and it is most valuable as elucidating the reasons which render such practice successful.

GENERAL SUPERINTENDENT.

Chicago, August 10, 1899.

WESTINGHOUSE BRAKES IN RUSSIA.

Editor "American Engineer":

Statements have been published to the effect that the New York Air Brake Company has secured portions of the large orders for air brake equipment for the railroads of Russia, to be filled during the next three and a half years. In reply to your inquiry as to what we can say in reference to this matter we are glad to make the following statement:

It was not until negotiation with the Russian Government had proceeded so far that the business of supplying the brake apparatus for the Imperial State Railways was practically assured to us, that the Russian Company was established and the construction of a manufacturing plant was begun.

About the end of last year, we secured from the Russian Government an order for about \$2,000,000 worth of air brake material for the State Railways. During January of the present year a congress of representatives of the rolling stock departments of all the private as well as the Government railways was called, and, after extended deliberation, the Westinghouse quick-action air brake system was adopted as the standard for all railways, private and state.

On the 5th of June, an imperial decree was issued which announced and ordered that:

(1) All freight locomotives and tenders, and a sufficient number of freight cars to secure brake control of all freight trains

within the Russian Empire, must be equipped with air brake apparatus prior to January 1st, 1903;

(2) The Westinghouse air brake has been adopted and must be purchased for this purpose by all roads, private and state;

(3) The use of any other kind or make of air brake than the Westinghouse is prohibited, with the provision, however, that a trial of any other brake system may be made, in connection with the Westinghouse, upon local trains. Each such trial must be conducted, under the direction of the Imperial Brake Commission, for a period of at least three years, after which the suitability of the brake so tried must be considered by a congress of rolling stock representatives of all the railways, and the conclusions of this congress must thereafter be submitted to Imperial ratification before any such brake can be used in general service.

In view of the facts above stated, it will be perfectly clear that any statement to the effect that we have not secured the Russian air brake business, or that the New York Air Brake Company has secured or can secure any portion of the enormous air brake business during the next three and one half years in the Russian Empire, is and must be entirely without foundation. The use of the New York Air Brake Company's apparatus is not only not contemplated upon any railroad in Russia, but is expressly prohibited for at least three years to come, except for experimental purposes upon local trains, under the permission and direction of the Imperial Brake Commission.

We have in our possession a translated copy of the Imperial decree of June 5th, which we shall be pleased to submit to your perusal in verification of the above statements.

It gives us pleasure to add that the demands for the output of our Russian plant, to comply with the requirements of the Imperial decree, necessitates its immediate enlargement to double its present capacity, and we have taken steps in that direction. It is estimated that we shall be required to supply air brake fixtures for about 350 locomotives and tenders and 1,750 freight cars, per month, during the next three and a half years.

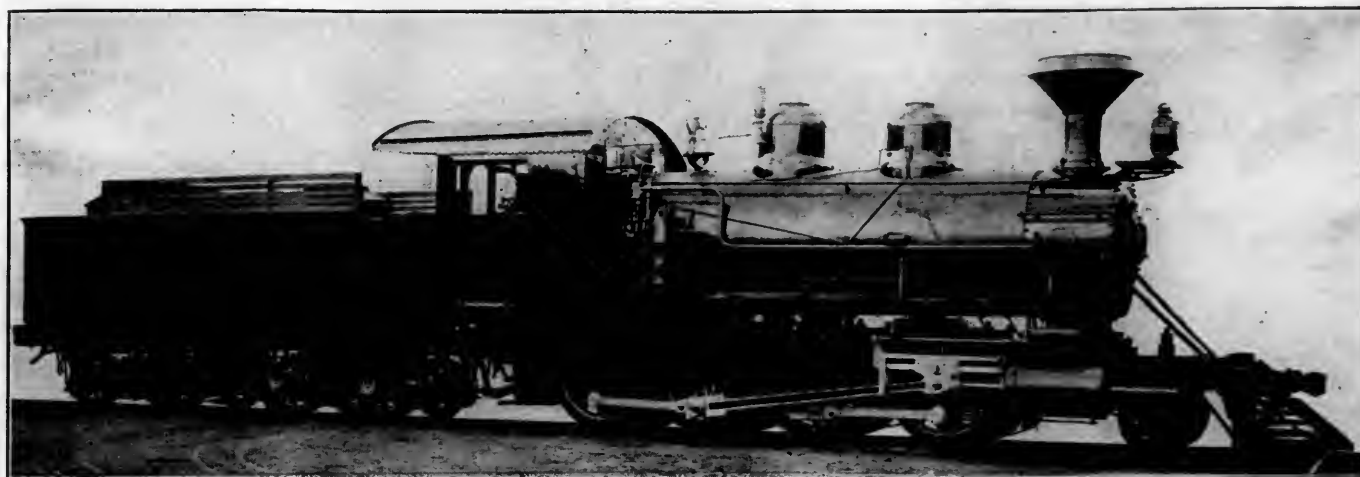
THE WESTINGHOUSE AIR BRAKE CO.,

H. H. Westinghouse, General Manager.

Pittsburgh, July 28, 1899.

The relatively large average train load of 425 tons is reported by President Ingalls of the Chesapeake & Ohio for the year ending June 30, 1899. The average train load for this road in 1897 was 259 tons, and it has risen steadily until it has reached the high figure given. It is stated that for the year ending in 1898 the New York Central reported an average train load of 299 tons, the Erie 300, the Lake Shore 352, the Great Northern 316, the Baltimore & Ohio 314 and the Norfolk & Western 355 tons.

The change from steam to electric traction on the Manhattan Railway of New York City has been started by the beginning of work on the new power house between 74th and 75th Streets on the East River. This power house will provide for the largest collection of steam and electrical machinery ever united in a single plant, and is particularly interesting because of the large power units which are to be used. The aggregate power of the plant when pushed to its limit of capacity will be nearly 100,000 horse power, and the units will be of 8,000 horse power each at their rated capacity, but each is to be capable of carrying a 50 per cent. overload for continuous service. The selection of these large units has caused comment among steam engineers merely on account of their size, because a breakdown or temporary disability of one of the engines will deprive the plant of the use of such a large amount of power. In this case, however, the units are no larger in proportion to the total size of the plant than are ordinarily found in smaller power houses. This fact does not detract from the interest in this installation, which is a remarkable one in every way. The boiler plant is also the largest ever assembled in one place and the order for the boilers, which is mentioned elsewhere as having been given to the Babcock & Wilcox Company, is the largest single order for boilers which has ever been placed.



Consolidation Locomotives—Santa Fe Pacific Railway.

DICKSON LOCOMOTIVE WORKS, Builders.

CONSOLIDATION LOCOMOTIVES.

Santa Fe Pacific Railway.

Dickson Manufacturing Company, Builders.

The Dickson Manufacturing Company have completed 10 consolidation locomotives for the Santa Fe Pacific in accordance with specifications furnished by Mr. John Player, Superintendent of Motive Power of the Atchison, Topeka & Santa Fe Railway.

Cast steel has been used extensively in these engines, the principal parts made of this material being the frames, driving boxes, steam chests and covers, driving wheels, equalizers, guide yokes and guide yoke brackets, brake hangers, cross heads, rocker arms, tumbling shafts, reverse levers, pedestals, radius bars and other smaller parts.

The engines have extended piston rods, Mr. G. A. Hancock's design of pilot coupler, which is adjustable in height to suit varying heights of pilots, the Rushforth feed water heater, and the Sweeney air brake attachment. Four pneumatic blow-off cocks are provided, three in the water legs and one under the barrel of the boiler. The crown staying is Mr. Player's combination of crown bars and sling stays.

The light weight of the tender is stated to be 39,000 pounds, which corresponds to the 5,000 gallon tank formerly used. The tanks on these tenders carry 6,000 gallons, the frames being lengthened two feet to accommodate them. The tank projects over the frame for the purpose of carrying condensation and other water free of the frames.

The chief dimensions of the engines are presented in the following table:

Type	Consolidation
Gage	4 ft. 8½ in.
Kind of fuel	Gallup lignite
Weight on drivers	140,625 lbs.
Weight on truck wheels	15,375 lbs.
Weight, total of engine in working order	156,000 lbs.
Weight of tender	light, 39,000 lbs.; loaded, 110,000 lbs.
Cylinders	21 by 28 in.
Wheel base, total of engine	23 ft. 3 in.
Wheel base, driving wheels	15 ft. 2 in.
Height, center of boiler above rail	8 ft. 2½ in.
Height, stack above rail	15 ft. 14 in.
Heating surface firebox	153.6 sq. ft.
Heating surface tubes	1687.2 sq. ft.
Heating surface, total	1840.8 sq. ft.
Grate area	29.25 sq. ft.
Drivers, diameter	57 in.
Truck wheels, diameter	30 in.
Truck wheels, centers	wrought-iron centers
Journals, driving axles	8 x 9 in.
Journals, truck axles	5½ in. x 10 in.
Main crank pins	6 x 6½ in.
Cylinders	21 x 28 in.
Piston rod diameter	4 in. extension 3 in. diameter
Main rod length	123½ in.
Steam ports	18 x 1½ in.
Exhaust ports	18 x 3 in.
Bridge length	1½ in.

Valves, greatest travel	5½ in.
Valves, outside lap	¾ in.
Valves, inside lap or clearance	line and line
Valves, lead in full gear	1½ in. blind
Boiler, types of	straight
Boiler working pressure	180 lbs.
Boiler, thickness barrel sheets	¾ in., throat 1 1/16 in.
Boiler, diameter barrel sheets	66½ in., first course
Boiler tube sheets	front 9/16 in. thick, back 11/16 in. thick
Firebox crown sheets	¾ in., 9/16 in. thick
Firebox crown sheets	stayed with crown bars and sling stay
Firebox length	8 ft. 7 in.
Firebox width	42 in.
Firebox depth, front and back	61¾ in.
Firebox brick arch	Yes
Firebox water spaces, front, back and sides	4 in.
Tubes	Number 233 outside diameter 2 in.
Tubes, length over sheets	13 ft. 10 in.
Dome, diameter	30 in.
Smokebox, diameter inside	68 in., length 43½ in.
Exhaust nozzle	Single, short, with petticoat pipe
Exhaust nozzle, diameter	4¼ in.
Exhaust nozzle tip, distance below center of boiler	22½ in.
Stack, diameter	S. F. P. pattern, cast-iron barrel
Stack, least diameter	16 in.
Stack, height above smokebox	47 in.

Tender.

Type	A. T. & O. F., sloping top sheets in coal space
Trucks	Play-er cast-steel swivel arch bar trucks with cast steel rigid bolster
Tanks, capacity	Water 6,000 gallons, coal 10 tons
Tank material	Steel 5/16 in. thick top and bottom
Tank material	Steel ¼ in. thick sides
Tank, under frame	A. T. & S. F. standard steel construction
Truck wheels, diameter	33 in.
Truck axles, diameter and length journals	5 in. x 9 in.
Truck axles, distance between centers of journals	76 in.
Truck wheel base	62 in.
Truck bolster	Rigid Player cast-steel
Type of body transom	Channel
Length of tender frame	22 ft. 7½ in.
Length of tender frame over bumpers	23 ft. 10½ in.
Length of tank	22 ft. 3 in.; width, 9 ft. 6 in.
Height of tank	Under collar 59½ in., over collar 63½ in.

The Sweeney Air Compressor is illustrated on page 287 of this issue.

THE TRAVELING ENGINEERS' ASSOCIATION.

The seventh annual convention of the Traveling Engineers' Association will be held at the Grand Hotel, Cincinnati, Ohio, September 12, and will continue several days. Secretary Thompson states that the reports this year are unusually valuable and that a very profitable convention is assured. The motto of the association is "To Improve the Locomotive Service of American Railroads," and the past history of the organization entitles it to support and encouragement from the higher officers.

The acetylene gas plant of the Logansport and Wabash Valley Gas Co., at Wabash, Ind., exploded August 7, with destructive effect. This is the first plant installed in this country on so large a scale and has been in use about a year in lighting the city. This accident, which does not appear to have been satisfactorily explained, will tend to cause a renewal of distrust of this gas.

SODA ASH IN LOCOMOTIVE BOILERS.

The chemical features of water purification in general and the action of soda ash in particular as applied to locomotive practice was so neatly summed up by Mr. H. E. Smith, Chemist of the Chicago, Milwaukee & St. Paul Ry., before the Master Mechanics' Association recently, that we desire to record it in our columns, as follows:

The solids present in boiler waters may be divided into two classes, the incrusting and non-incrusting solids. In the majority of boiler waters of the United States the incrusting solids consist largely of calcium and magnesium carbonates, and calcium sulphates. Under the action of heat alone, the carbonates are precipitated at 212 degrees Fahrenheit and the sulphate at about 260 degrees Fahrenheit. The sulphate is much more injurious than the carbonate, because it forms a much harder and denser incrustation. Occasionally magnesium sulphate or chloride is present. These two substances are soluble in water, but when heated under pressure, especially if in the presence of iron, are decomposed, magnesium hydroxide being precipitated as incrustation, while the acid is set free, as a corrosive element. Silica, alumina and oxide of iron are generally present in small amounts and enter the incrustation.

The non-incrusting solids are the compounds of the alkalies, and are usually made up of sodium and potassium sulphates, and sodium chloride. Sodium carbonate and potassium chloride are sometimes present. None of these compounds form incrustations, but, on the other hand, cause foaming if present in large amounts. Our experiments indicate that other things being equal, the various alkali compounds are about equally efficient in producing foaming.

In actual practice, however, the carbonates produce a flocculent sludge with waters containing calcium and magnesium compounds, and on this account are indirectly more efficient than sulphates or chlorides in producing foaming.

Occasionally free mineral acid, generally sulphuric acid, is found in natural waters, and produces corrosion. Sewage, and some kinds of factory waste produce both foaming and corrosion. Suspended solids obviously produce incrustation, and sometimes foaming. When waters are treated in the boiler with soda ash, the incrusting solids are changed to carbonates and precipitated as a soft sludge, which is readily blown out, instead of coming down in crystalline condition and adhering to the surface of the boiler. Extended experience has shown that it is not necessary to use as large an amount of soda ash as the full chemical equivalent of the incrusting solids. This is of very decided advantage in boiler operation. There appear to be several reasons for this fact, as follows:

1. If no precipitant is used, all of the nominally incrusting solids do not immediately adhere to the boiler, but may be easily removed by blowing or washing.

2. When soda ash acts upon calcium and magnesium sulphates it is changed to sodium sulphate, which has no further action as a precipitant. But calcium and magnesium carbonates require for their precipitation only the absorption of the free carbonic acid gas of the water. This action leaves the soda ash in the form of bicarbonate, which, by the heat of the boiler, is gradually changed back to the normal carbonate (soda ash), which can then act upon a fresh portion of incrusting solids.

3. The flocculent sludge produced by the direct action of the soda ash doubtless incloses particles of crystalline solids which are thrown down by heat alone, thereby preventing them from adhering to the boiler.

In calculating the amount of soda ash to be used, we employ the following table of ratios, which represents present average practice:

One grain of the following salts per gallon of feed water.	Requires per 1,000 gallons of feed water, the following amounts of 53° soda ash.
Calcium or magnesium carbonate.....	0.02 pound.
Calcium sulphate.....	0.10 "
Magnesium sulphate.....	0.13 "
Magnesium chloride.....	0.16 "

The proper ratios to be employed vary somewhat according to the amount and character of the incrusting solids and the amounts of alkalis in the waters. They also vary according to the service of boilers and the care used in blowing and washing out. The ratios given are suitable for the average waters of the Mississippi Valley, for boilers which receive reasonably good care. The proportion of the soda ash specified for carbonates is only about one-seventh of the chemical equivalent,

That for calcium sulphate is nearly the full equivalent, while for magnesium sulphate and chloride the theoretical amount is used on account of the corrosive nature of the salts. Some waters contain originally some sodium carbonate, in which case less soda ash is needed, or it may be entirely dispensed with.

On account of foaming, it is not desirable to use more than 10 pounds of soda ash per 100 miles, even if the calculation calls for more.

THE NEW YORK STATE CANALS.

Their Greatest Usefulness Gone.

Canals have exerted a powerful influence on the transportation interests of this country. They have tended to improve railroad methods until the cost of rail transportation is now so much below that of the canal as to place the latter in the background as an institution which has lost its influence. In considering the question of what is to be done with the canals of New York State, Governor Roosevelt invited the expression of opinion of leading men, having knowledge of the subject, for guidance in future legislation. The whole correspondence, which is very voluminous, is interesting. It develops the fact, now admitted by the men who were formerly strong advocates of the canals, that while these waterways have in the past served to keep railroad rates in check, they are now outclassed by the railroads, which, by the introduction of improved methods, have reduced the cost of transportation to as low a point as three mills per ton per mile. Thus the canal has lost its greatest usefulness, and it is not likely that large sums of money will be invested in their improvement and further development. It is probable that the canals will be maintained, but which of the first four of the following five propositions will be carried out it is impossible to predict:

First.—To complete the present project of enlarging the Erie, Oswego and Champlain Canals at a further cost of \$15,000,000 (or \$24,000,000 in all).

Second.—To enlarge the present locks of the Erie Canal at once to a length of 260 feet, a width of 26 feet and depth of 11 feet, making them suitable for boats 25 feet wide, 125 feet long and 10 feet draught. This project would cost about \$6,000,000.

Third.—To construct a barge canal continuously descending all the way to the Hudson River from Lake Erie, with a depth of 12 feet, and suitable for barges of 1,200 to 1,500 tons, which can be towed on the lakes, if desired. The cost of this is approximately estimated at \$50,000,000.

Fourth.—To construct a ship canal with a depth of 20 to 30 feet, suitable for lake and ocean vessels of 5,000 to 10,000 tons capacity. The cost of such a ship canal, depending upon its size and route adopted, is estimated at from \$200,000,000 to \$500,000,000.

Fifth.—To abandon the canals entirely, as has been done in some other states, and dispose of the property interests therein to private individuals or corporations on the best terms that can be secured, or to make some other use of the property for the benefit of the state.

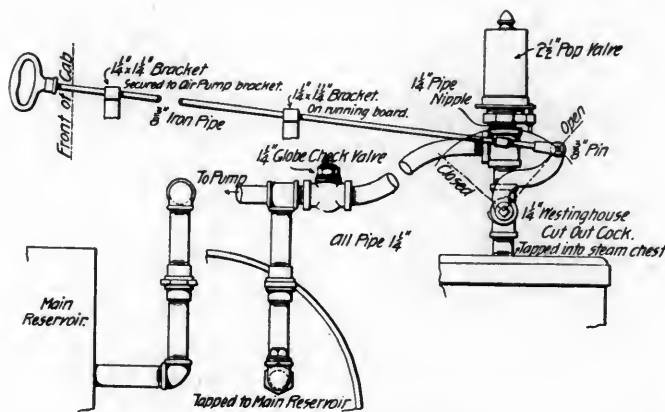
Two large, self-propelling steel dredges are to be built by the Maryland Steel Co. for the work of dredging the new channel to New York harbor. They are to be similar to those used in England on the Mersey and will cost about \$450,000 each. They are to be of the suction type and will deposit the material in immense hoppers on the dredges holding 3,500 tons and will steam out to sea at a speed of 12 miles per hour to dump it. The dredges will be 320 feet long, 48 feet beam and 26 feet deep. The propelling machinery will consist of two triple expansion engines with four cylinders each, driving twin screws and the hydraulic pumping suction machinery will be driven by independent tandem compound engines. Accommodations for officers and crew will be provided, so that the dredges will work night and day. The speed of working while dredging will be three miles per hour. It is expected that the first one will be ready for service next May and the second a little later.

THE SWEENEY AIR COMPRESSOR.

This device, which is applied to the Santa Fe Pacific locomotives, illustrated elsewhere in this issue, is very well known and highly prized on some of the western roads having heavy grades, but is not used elsewhere. It is not an air compressor, but is an attachment applied to one or both main steam cylinders of the locomotive, whereby they are made to compress air into the main reservoir for temporary relief of the air brake pump. The originator, Thomas Sweeney, is a locomotive engineer on the Southern Pacific, and his purpose was to provide means for maintaining air pressure in the train pipe in case of failure of the air pump and in recharging when descending long mountain grades.

The device consists of a pipe connecting the top or side of the steam chest with the main air reservoir, the passage between the two being controlled by a stop cock at the steam chest and a check valve near the reservoir. A pop valve set to open at a pressure of 90 pounds, is mounted in the pipe and the apparatus is completed by a connection from the stop cock and the cab, whereby the engineer may open or close it.

When it is necessary to use the device, steam being shut off, the reverse lever is placed slightly back of center notch and



The Sweeney Air Compressor.

the cylinder cocks left open for three or four revolutions of the engine to allow water that may be in the cylinders to escape; then the stop cock is opened and the brake valve placed in charging position. The reverse lever must be left back of the center notch at least fifteen seconds after full pressure has been indicated on the air gauge. Before the reverse lever is moved forward the brake valve is placed on lap; and, in case the air pump is not working, the stop cock should be closed, as the pistons will draw air from the main reservoir before the check valve closes. By placing the brake valve on the lap and closing the stop cock before moving the reverse lever forward, sufficient pressure will be retained in the main reservoir to release the brake. After the cylinders have ceased to work as air compressors the brake valve should be left on the lap at least five seconds, so that the air will have time to equalize in the train. If the air is used immediately after moving the lever ahead, there being a higher pressure in the train pipe than in the auxiliary reservoirs, air will be wasted, as the air in the train pipe must be reduced to a lower pressure than in the auxiliary reservoirs to set the brakes; but, if time be allowed to let the air equalize, all the air that has been forced back may be used to advantage. The device is used only in emergencies, and the rules provide for testing it at the beginning of every trip, in order to insure its use if needed. It is confidently depended upon by the men and is fitted to many locomotives that are used on long, heavy grades on the Santa Fe, the Southern Pacific and mountain roads in the far Northwest.

Mr. H. J. Small, Superintendent of Motive Power of the Southern Pacific, writes us that this device originated with one of the oldest engineers on that road. Some years ago, when the question of the advisability of equipping mountain locomotives with two air pumps was considered, the Sweeney device was introduced and it proved satisfactory, so that the idea of using a second air pump was abandoned. Mr. Small reports that he is now using this device not only on the mountain grades, but also on valley divisions. It is used as an emergency or auxiliary to the air pump. In case anything happens to the air pump, this device is ready for instant use. A number of cases of failure of air pumps have occurred on that road, not only on mountain grades, but on level divisions, and the trains were brought in safely, using the air brakes for which the supply of air was furnished solely by the Sweeney auxiliary.

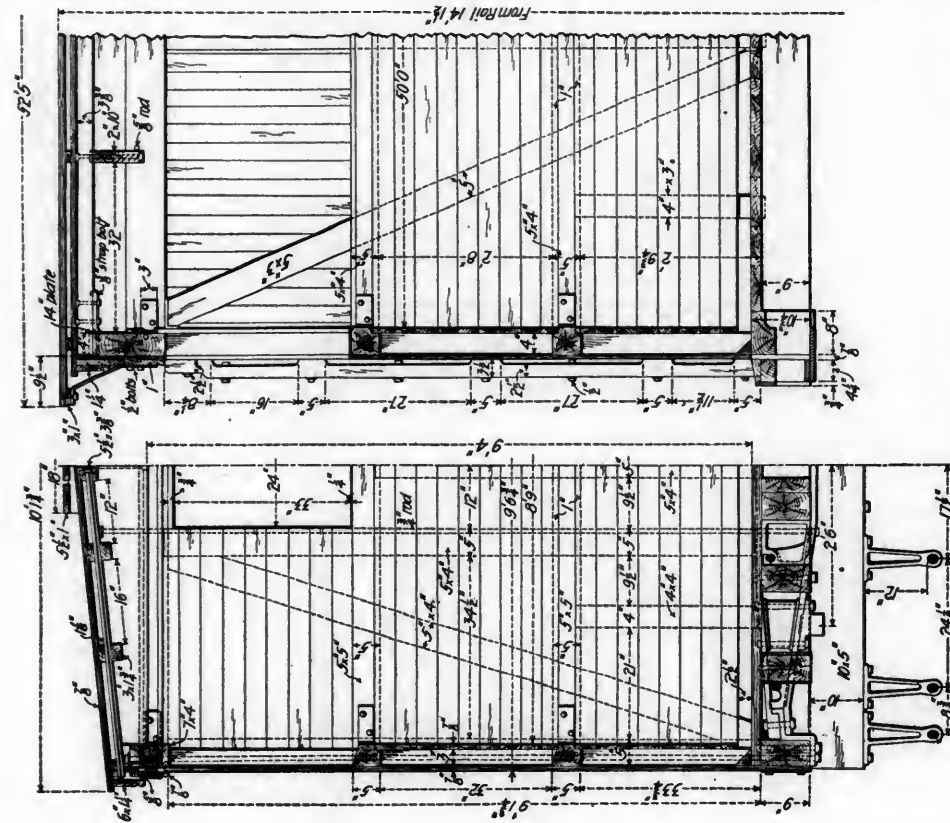
Mr. Small has very kindly sent us a report written by the Pacific Coast expert of the Westinghouse Air Brake Company, after witnessing the use of the Sweeney attachment on three different trains. In one of these cases one of the air valves of the locomotive air pump broke and a train of 560 tons was handled down a 3 per cent. grade, 25 miles long, with this device. There can be no doubt that with such grades, and even with shorter ones, and not as steep, this emergency apparatus will contribute to the safety of operation and also to the peace of mind of the engine and train crews.

BRAKE CONTROL OF DOUBLE-HEADED PASSENGER TRAINS.

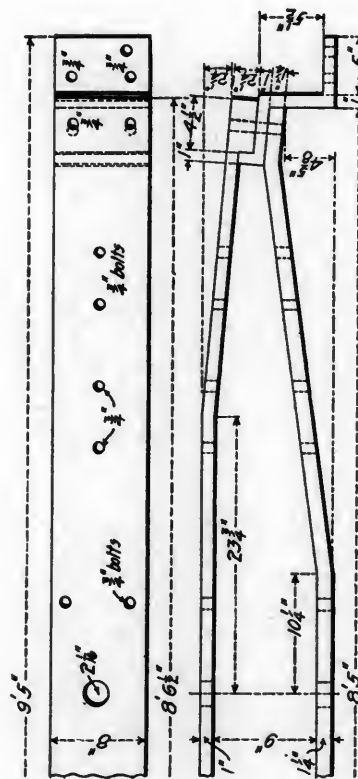
There is an opportunity for an accident whenever two locomotives are attached to the same train from the possibility of conflict of the enginemen in applying the brakes. Some protection against this contingency is necessary and specially so on mountain grades, where double-heading of passenger trains is the rule. In discussing the practice of cutting out the brakes on the leading engine before the Master Mechanics' Association, Mr. T. R. Browne and Mr. A. W. Gibbs, of the Pennsylvania, stated that on this road the engineer of the leading engine did the braking, the arrangement of the engineer's valve permitted the engineman of the rear engine only to apply the brakes. It was expressly arranged that he would not be able to release the brakes, for the reason that should the forward engineman discover the necessity of applying the brakes, while the engineman of the second engine had left his brake in a released position, the result would be a brake failure. Therefore the brakes are so arranged with double-headed passenger trains that the forward engineman has control not only of his own brakes and the train brakes, but also those of the rear engine; the rear man not having the power to release, Mr. Browne said:

This condition is somewhat altered on the mountain division, where double-headers are used for short distance only, and under these circumstances the engine next to the train controls and applies the brakes. It would appear to me that the head engine being in the lead should have the ability to apply the brakes, as the crew is in a position to see all the signals, as well as the second engine. It seems to me that to cut out the head engine entirely removes to a certain extent the possibility of throwing a part of the responsibility on that crew and throws it all upon the engine behind. From the standpoint of my experience and judgment in that matter I would naturally feel inclined to say that both crews should have it within their power to apply brakes on double-headers, which usually means a heavy train.

German engineers are pursuing improvement in steam engine efficiency by the use of superheated steam, and one direction which their progress is taking is the use of poppet valves to avoid the earlier difficulties of cutting and tearing valves, valve stems and seats. There is so much to be gained by superheating that it is well worth while experimenting, even at considerable expense, in order to overcome the difficulties.

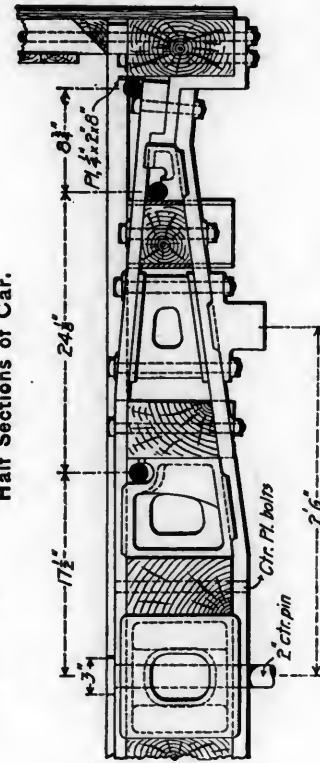


Plan View Showing Underframe.



Plan and Elevation of Body Bolster.

Half Sections of Car.



Half Section at Body Bolster.

50 Foot Furniture Cars, 60,000 Pounds Capacity.
Baltimore & Ohio Southwestern Ry.

50-FOOT FURNITURE CARS.

Baltimore & Ohio Southwestern.

Box cars 50 ft. 10 in. long over end sills and 9 ft. 5 in. wide over side sills, having a clear height inside of 9 ft. 4 in. under the car-lines, are always interesting, even if they do not present novelties in the framing. Furniture cars with these dimensions are to be built for the Baltimore & Ohio Southwestern, several drawings of which are presented here.

These cars have eight longitudinal sills, all of which are 5 by 9 inches in section, supported by six 1½-inch truss rods upset to 1¾ inches at the ends. The needle beams are 5 by 10 inches in section and the queen posts are deep enough to bring the tops of the truss rods 22 inches below the lower faces of the sills. The truss rods are arranged as shown in the section of the under-frame at the body bolster. Two of them lie between the side sills and the first intermediate sill on each side, while the others lie at a distance of 17½ inches at each side of the center of the car. This distribution brings the greater part of the truss rod load near the ends of the body bolsters and may be criticised in the light of Mr. F. M. Whyte's paper before the Western Railway Club last year (See our January, 1899, issue, page 17), especially because of the great length of this car on account of which the duty imposed upon the truss rods is greater than is the case in shorter cars.

The end sills are 8 by 10¾ inches, the longitudinal sills are tenoned into them with double tenons 1½ by 1½ inches with a 3-inch space between them. The other principal timbers are of the following sections: Side plates, 4 by 7 inches; end plates, 4 by 14 inches at the center, tapered to 8¾ inches at the ends; carlines, 2 by 10 inches; purlines, 1¾ by 3 inches; ridge pole, 3¾ by 5½ inches; door posts, 4 by 6 inches; end posts, 4 by 5 inches, and needle beams, 5 by 10 inches. The girths are double and 4 by 5 inches in section. The wheat line is 37 inches above the floor, and the corn line 40 inches, the capacity being 60,000 lbs.

The body bolster is of the plate type, the upper plate being 1 by 8 inches and the lower 1¼ by 8 inches, with a depth of 9 inches between the plates at the center. The connections between the ends of the plates are made over by 1 by 8-inch plate stirrups carrying the side sills. The center plates are malleable iron. By referring to the section at the body bolster and also the plan view it will be seen that the outside intermediate sills are reinforced by ¾ by 9-inch plates, 6 ft. long, where they are cut out for the bolsters. As shown in the drawings, the draft gear is located between the center sills, the front draft lugs being supported against the end sills, while the rear lugs bear against blocks bolted to the center sills and extending back to the bolsters. The central bolts through these blocks take the ends of tension rods passing through the end sills and dead blocks. The trucks of these cars have bolsters made of three pieces of oak, two of which are 3¾ by 7½ inches, and the other 4 by 7 inches, with sandwich plates between them. This is a type of truck bolster of which the future will produce very few examples. These cars are a little longer than the 50-foot carriage cars built last year by the Chicago, Milwaukee & St. Paul and illustrated on page 8 of our issue of January, 1899.

VACUUM STEAM HEATING.

The relative advantages of pressure and vacuum in the pipes of steam heating systems have been investigated by Prof. J. H. Kinealy of St. Louis and reported by him in a paper before the American Society of Heating and Ventilating Engineers. The experiments were conducted in a small room on the street floor of a large office building in St. Louis, the outer walls being subjected to the temperature of the air out of doors. A radiator was used for heating and a connection was made to it for the

air valves of the Paul system. Temperatures were taken at points about 5 feet from the floor.

The conclusions drawn from the tests are that it is more economical to heat with steam at a temperature less than 212 degrees than with steam at higher temperatures, and that the less the difference between the temperature of the steam in the radiator and the temperature of the air in the room measured at about five feet from the floor, the greater is the economy in the use of steam in heating, and this does not take into consideration the fact that steam for a vacuum system may be taken from an exhaust pipe without costing anything, but it is due to the low temperatures used. The author quoted experiments by Meidinger to show that radiators at high temperatures probably keep the air at the top of the room at a much higher temperature, for a temperature of 70 degrees at a point 5 feet above the floor, than a radiator at lower temperature would keep it and yet maintain the same temperature, 70 degrees, at the height of 5 feet. This meant a greater loss of heat with the high radiator temperatures, because they gave higher average temperatures in the room which resulted in a greater difference between the outside and inside temperatures, and this, in turn, caused greater loss of heat from the room and a corresponding consumption of fuel. The occupants of a room use the portion up to about 5 feet from the floor, and therefore that system was best which would maintain the lower 5 feet at the desired temperature and keep the lowest ceiling temperature. The author believed that this object was best attained by radiators having low temperatures.

The author then discussed the question of increasing the area of radiating surface to correspond with the reduction in the temperature of the radiator. The higher the radiator temperature the more steam would be condensed per square foot of surface per hour, but it did not necessarily follow that low temperatures required more surface because of the fact that in a vacuum system the air in the radiators is always withdrawn from the coils by the vacuum attachment, which made it possible to keep the radiators entirely full of steam. This gave the vacuum system the advantage because it insured against the short circuiting of the radiators on account of becoming "air bound." The radiator of the vacuum system employed their surfaces more efficiently, and the radiating surfaces of this system are therefore always larger than those having more or less air in them, which can never be completely removed in a system using pressures above the atmosphere. A more complete statement of Prof. Kinealy's work and his conclusions may be found in "The Engineering Record," July 29, 1899, page 202.

The length of boiler tubes is important, and it has been questioned whether increased heating surface may not be better obtained in some other way. There is probably a best ratio between the length and diameter of tubes, but this does not seem to have been clearly established for locomotive practice. The experiments of Mr. Henry of the Paris-Lyons-Mediterranean Railway show that while increasing the length of tubes increases the boiler efficiency, an increase of 130 per cent. in length adds but about 30 per cent. to the amount of water evaporated per pound of coal. These results are summarized as follows:

Experiments on Heating Surface, Paris-Lyons-Mediterranean Ry.					
Length of tubes in feet.....	9.84	13.1	16.4	19.7	23.0
Total heating surface, sq. ft....	972.2	1260.	1548.	1835.	2122.
Ratio heating to grate surface..	36.13	46.82	57.52	68.21	78.91
Draft of One Inch of Water.					
	lbs.	lbs.	lbs.	lbs.	lbs.
Combustion per square foot of grate	38.21	36.8	33.1	30.3	28.9
Water per pound of coal	7.87	9.01	9.65	9.94	10.20
	deg.	deg.	deg.	deg.	deg.
Temperature of smoke box	739.	608.	518.	460.	432.
	%	%	%	%	%
Loss of heat by chimney	17.4	13.7	11.4	10.2	9.77

TWO IMPROVEMENTS IN COMPOUND LOCOMOTIVES.

Richmond Locomotive and Machine Works.

Mr. C. J. Mellin, Chief Engineer of the Richmond Locomotive and Machine Works, has sent us drawings and information concerning two apparently important improvements in compound locomotives, both of which concern the losses of power, one in the disposition of the exhaust through the valve, and the other in a reduction of the resistance to the motion of the piston when drifting, and this effect is accompanied by the elimination of the draft action of the large cylinder when running with steam shut off. Mr. Mellin states that both improvements give good results as to increasing the speed, power and

ginning of the return stroke is of very little value. The pressure at the end of the stroke should therefore be decreased in order to secure a minimum back pressure throughout the stroke. The valve under consideration was designed to secure a more rapid exhaust opening, and is termed "double ported," to distinguish it from the Allen valve. The valve port is used as an exhaust as well as an admission passage. The use of this device on compound locomotives gives low back pressure at high speeds without necessitating the use of large valves. The advantage of small valves and short valve travel on freight engines is fully appreciated. While this plan is working very satisfactorily on high-speed locomotives on the St. Louis Southwestern, we have no record of the speed except the report that it is satisfactory.

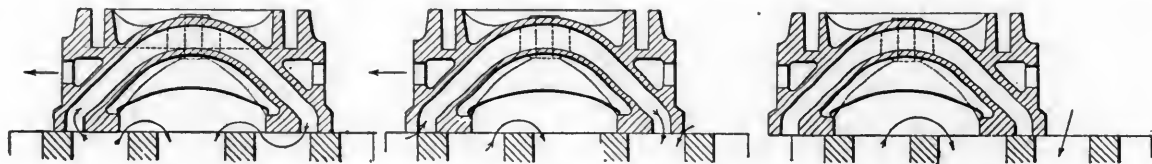


Fig. 1.—Mr. Mellin's Arrangement of the Allen Valve to Secure Double Port Effect.

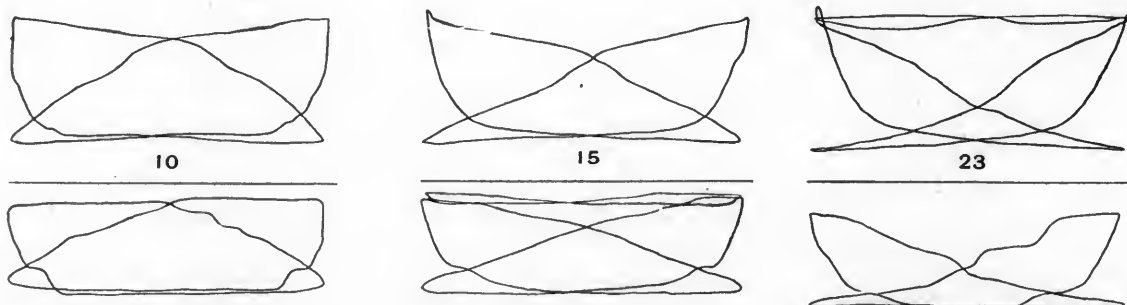
economy of compounds, and their effects are particularly noticeable at high speeds.

Double Ported Valve Controlling Exhaust as Well as Admission.

The Allen valve has proved a success in locomotive practice and it appears to be constantly gaining friends because of its effective aid in improving the admission of steam. This port does not affect the action of the exhaust side of the valve and Mr. Mellin's new valve was designed to accomplish what the Allen valve does and also improve the disposition of the exhaust. This is an adaptation of the Allen port combined with a large amount of inside clearance of the main exhaust passage of the valve. The following description was prepared from information received from Mr. Mellin:

The time when the opening for the exhaust needs to be most efficient is at the beginning of the exhaust period. It is evident that when the exhaust opening becomes equal to the area of the exhaust nozzle a further increase in the area of the exhaust port opening will not assist the steam out of the cylinder. With the increase in piston speed a certain velocity is reached, after which the back pressure during the return stroke of the piston does not decrease, and for this reason an increase of the area of the exhaust opening after the be-

The drawing, Fig. 1, illustrating various positions of the valve, shows that the auxiliary port acts as an exhaust port only during the first portion of the exhaust period. When the main exhaust passage becomes sufficiently open the supplemental passage closes and it afterward becomes temporarily an admission passage. The valve is shown in three positions, the arrows indicating the directions of the steam currents. Indicator cards and the valve diagram drawn above the ideal cards, are shown in Figs. 2 and 3. Fig. 3 illustrates the difference between the plain valve, the Allen ported valve and Mr. Mellin's device. These valves are shown when cutting off at half stroke. The full line, No. 1, represents the action of the double ported valve, the dotted line, No. 2, is that of the plain valve, and the broken line, No. 3, represents the Allen valve, all of the conditions being the same except as to the supplemental ports, and the diagram is drawn on the assumption that the velocity of the steam is the same at corresponding points on the three cards. The admission and expansion lines of No. 1 and No. 3 coincide, but the exhaust and back pressure lines of No. 1 show a decided advantage. From the release point, C, to E, the effect of the auxiliary exhaust passage is plain, and yet the area of the exhaust nozzle is still considerably larger than that of the port opening. The re-



Card No. 10.

Speed, miles per hour.....	23
Boiler pressure.....	174 lbs.
Initial pressure.....	171 lbs.
M. E. P., H. P.....	81.5 lbs.
L. P.....	28.6 lbs.
Distribution of work, H. P.....	53.2 per cent.
L. P.....	46.8 per cent.

Card No. 15.

Speed, miles per hour.....	35
Boiler pressure.....	180 lbs.
Initial pressure.....	175 lbs.
M. E. P., H. P.....	61.5 lbs.
L. P.....	21.5 lbs.
Distribution of work, H. P.....	53.2 per cent.
L. P.....	46.8 per cent.

Card No. 23.

Speed, miles per hour.....	41
Boiler pressure.....	180 lbs.
Initial pressure.....	165 lbs.
M. E. P., H. P.....	34.1 lbs.
L. P.....	14.8 lbs.
Distribution of work, H. P.....	47.9 per cent.
L. P.....	52.1 per cent.

Diameter of H. P. cylinder.....	20 1/4 in.
L. P.....	32 1/4 in.
Length of stroke.....	24 in.
Ratio of cylinder areas.....	2.51
Indicator spring, H. P.....	100 lbs.
L. P.....	40 lbs.

Inside clearance, front.....	H. P. 3/8 in.	L. P. 1 1/2 in.
back.....	3/8 in.	1 1/2 in.
Valve travel.....	5.78 in.	5.78 in.
Lead.....	1/8 in.	1/8 in.
Outside lap.....	1 1/4 in.	1 1/4 in.
Width of auxiliary port.....	3/8 in.	3/8 in.

Fig. 2.—Low Pressure Cylinder with Double Ported Valve.

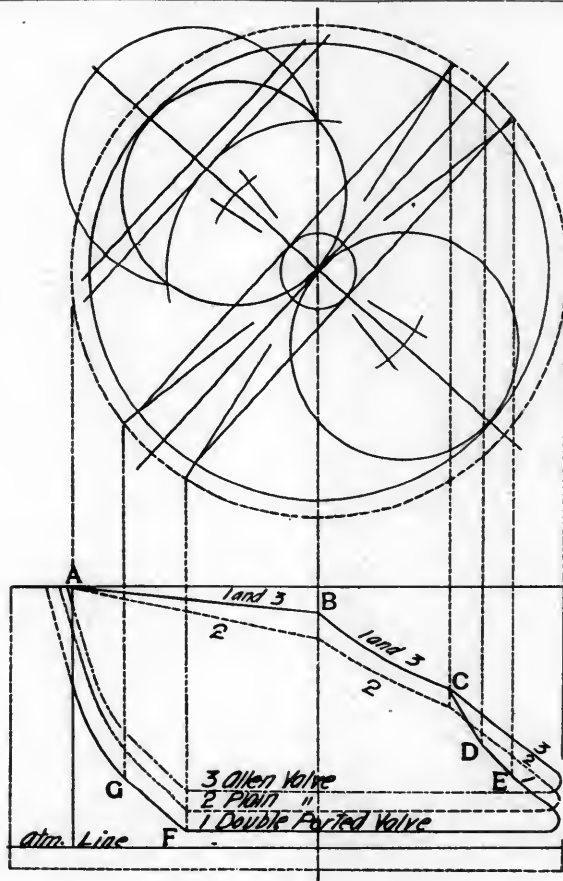


Fig. 3.—Comparisons of Valves.

sulting final pressure causes a lower back pressure during the entire return stroke.

The admission and expansion lines of the plain valve fall below those of the other valves, and the release pressure is correspondingly lower. As the area of the exhaust opening is the same for the plain and the Allen valves, the exhaust line of the plain valve is below the Allen, through the return stroke and the exhaust line of the Mellin valve crosses that of the plain valve at a point near the end of the stroke. Another advantage of the new valve is shown in Fig. 4, illustrating diagrams, the conditions which occur when drifting. The confined air is compressed to the pressure shown at A, when the auxiliary port opens to relieve the pressure by allowing the air to pass over to the suction side of the piston before the piston

parallel lines crossing the steam circle is the lead. The opening of the auxiliary port as an exhaust port and the negative lap are represented by the curves intersecting each other at the center of the figure. They are measured across the center of the figure on the reverse curves until the inclined center line is reached, after which it follows the small circle and the exhaust circle from the point of intersection of the latter circle. At the closing of the valve the opposite reverse curves go into effect in the same manner. The other points are connected with the diagrams below the valve diagram by projecting downward.

"By-Pass" Valves for Low-Pressure Cylinders of Compound Locomotives.

The pumping action of the low-pressure cylinder is rendered ineffective by a by-pass or "over-pass," which is an open passage from one end of the cylinder to the other. This passage is in a projection cast upon the outside of the cylinder just below the steam chest, which has become a feature of Richmond compounds. This valve was designed by Mr. Mellin. It is shown in relation to the steam passages and in both the open and closed position. The cylinders at the ends of the valve communicate with the valve chamber, and when the throttle is closed the vacuum in the chamber causes the valves, A A, Fig. 5, to separate and open the passage between the ends of the cylinder. Upon the opening of the throttle the steam pressure from the valve chamber comes upon the valves, A A, Fig. 6, forcing them toward each other and closing communication through the by-pass. A small vent at the center of the by-pass opens to the atmosphere. It is found advisable to admit some external air in order to prevent the cylinder from becoming too highly heated through friction of the air, and also to insure against drawing smokebox gases into the cylinder. The double piston shown in the engravings is used to cushion the movements of the by-pass valves. These valves are made as large as 5 inches in diameter, and their movements are very rapid.

The two-cylinder compound has not been considered as a favorable type for use where much drifting is to be done because of the pumping action of the large cylinder, which has an important fanning effect on the fire when the engine is running with the throttle closed. There has also been some trouble with the lubrication of the large cylinders, and in spite of large relief valves which have been applied to steam chests the trouble has not yet been satisfactorily overcome by taking in exterior air in this way. Admitting fresh air also has the disadvantage of cooling off the cylinder, which causes a large amount of condensation when steam is again admitted. Mr. Mellin's device avoids this trouble and affords relief that could not be obtained without using excessively large relief valves.

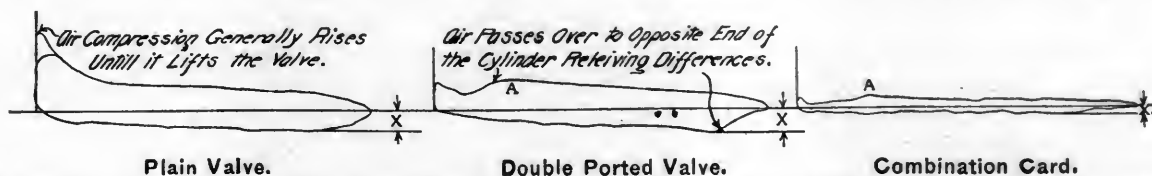


Fig. 4.—Illustrations Showing Effects of Double Ported Valves, Plain Valves and Combination of Double Ported Valve and By Pass Valve.

reaches the end of its stroke, and the final compression is much lower than it would be with a plain valve. This engraving, Fig. 4, brings out the combined effect of the double ported valve and the "over-pass" valve in reducing the air resistance of the piston when drifting.

In the valve diagram, Fig. 3, the dotted outer circle represents the crank path, the next one gives the travel of the valve, the circle at the left is the steam, and that at the right the exhaust, the circle at the center of the figure being the negative exhaust lap circle. The inner crescent formed by the steam lap as a radius is the ordinary steam opening, and the outer crescent partly enclosing the former, represents the auxiliary port opening for steam. The distance between the straight

The cards taken from engines with and without these valves show the reason for the criticism often heard, to the effect that the gain secured by compounds running up hill and on level stretches of roads, where they must do a great deal of drifting, is lost again by the fanning of the fire by the action of the cylinders.

The drifting cards shown in Fig. 7 illustrate the effect of the over-pass valve in reducing the resistance to the motion of the piston. Diagrams A and B show cards from a Chesapeake & Ohio locomotive with 20 and 32-inch cylinders, before and after the over-pass device was applied. In card A the stroke was 24 inches. This was increased 2 inches when the change was made. Both cards were taken with the throt-

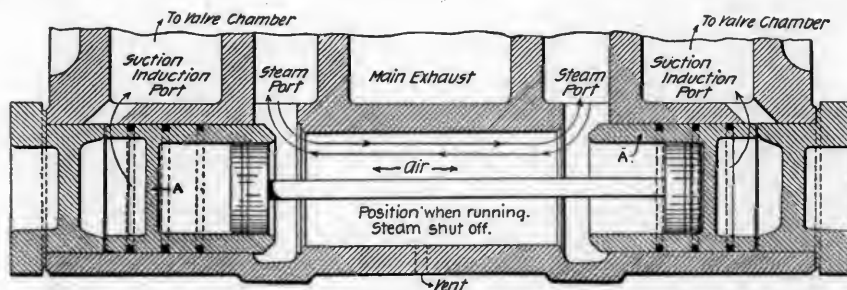


Fig. 5.—Position of By Pass Valve when Running with Steam Shut Off.

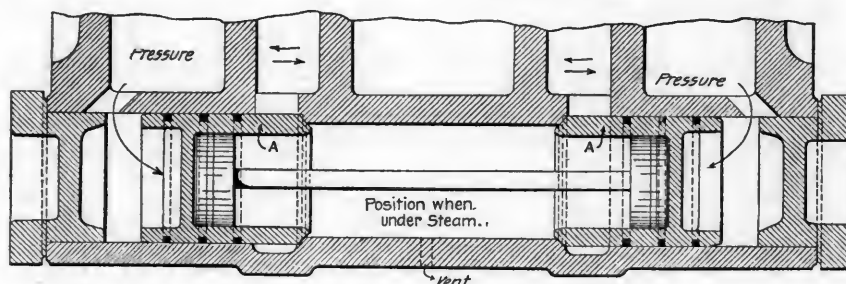


Fig. 6.—Position of By Pass Valve with Throttle Open.

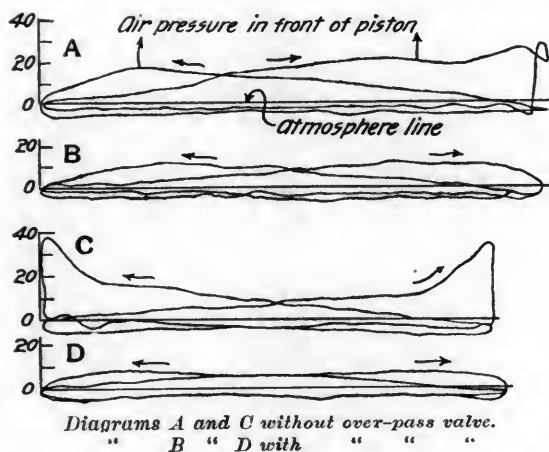


Fig. 7.—Indicator Cards from Low Pressure Cylinder of Richmond Compound when Drifting.

the closed and the reverse lever in the first notch. The piston speed for both cards was 986 feet per minute. It is stated that the cards from the high-pressure cylinder at this speed were approximately straight lines. Some irregularities in the pressure are shown in diagram A, which is attributed to yielding or springing in the indicator motion.

Cards C and D were taken from two locomotives with the same sized cylinders, 20 and 32 by 24-inch diameter, and at approximately 920 feet per minute piston speed. Card D shows the advantage of the over-pass. As previously stated, Fig. 4 shows the combined action of the double ported valve and the "over-pass."

The twin screw steamer "Chester W. Chapin" for the New York & New Haven Line, recently launched at the yards of the Maryland Steel Company, at Sparrow's Point, Md., is to cost \$500,000 and will have a speed of 21½ statute miles per hour. She is 324 feet long on deck, 310 feet on the water line, 64 feet wide over the guards and 17 feet 2½ inches deep. The engines are surface condensing, triple expansion, with cylinders 24, 38 and 60 inches diameter by 30 inches stroke. They are to develop 4,200 indicated horse power. The boilers, six in number, are of the Scotch type, 13 feet in diameter and 11 feet 6 inches long, working at a pressure of 160 pounds. The vessel will be heated by steam and lighted by electricity and is expected to be ready for service early in September.

CONVENIENT TABLE FOR TUBE HEATING SURFACES.

It is customary to compute the heating surface of tubes by considering the outside diameter and for convenience in getting at the figure for total tube heating surface quickly when the length, number and diameter of the tubes are known, Mr. Francis J. Cole arranged the accompanying table, for which

HEATING SURFACE OF FLUES IN SQUARE FEET.

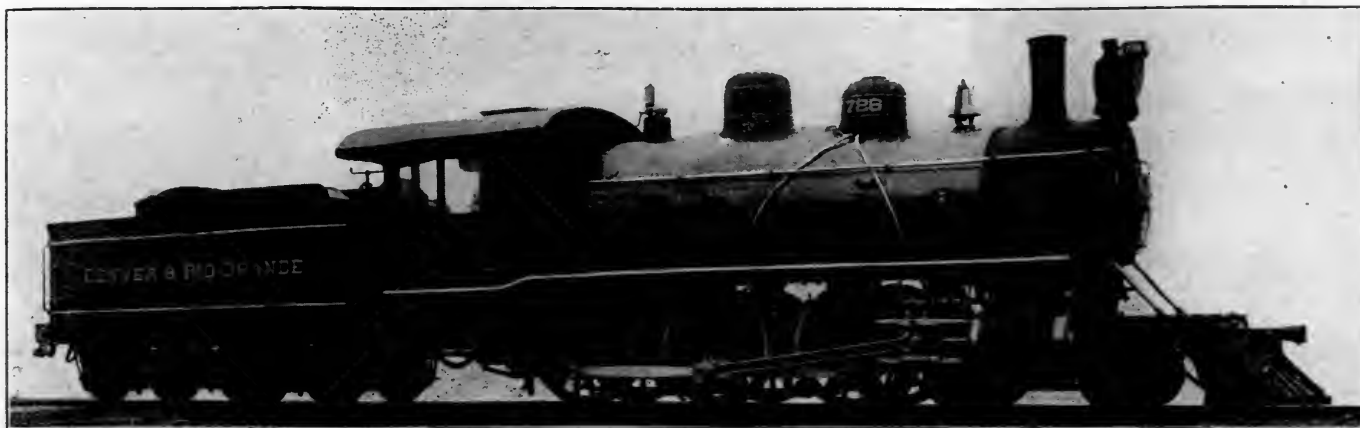
OUTSIDE DIAMETER.

Outside Diameter of Flues.	Circum- ferences in inches.	Feet.								
		7	8	9	10	11	12	13	14	15
1½	4.7124	2.749	3.139	3.531	3.924	4.316	4.709	5.111	5.494	5.886
1¾	5.4978	3.207	3.665	4.123	4.582	5.040	5.496	5.956	6.414	6.872
2	6.2832	3.635	4.189	4.712	5.236	5.760	6.283	6.807	7.330	7.854
2¼	7.0686	4.120	4.711	5.298	5.887	6.476	7.064	7.653	8.242	8.830
2½	7.8540	4.581	5.236	5.890	6.545	7.199	7.854	8.508	9.163	9.817

Outside Diameter of Flues.	Circumferences in inches.	Inches.											
		1	2	3	4	5	6	7	8	9	10	11	12
1½	4.7124	.033	.065	.097	.131	.164	.196	.229	.260	.294	.327	.360	.392
1¾	5.4978	.038	.076	.114	.152	.191	.229	.267	.305	.342	.382	.418	.458
2	6.2832	.044	.087	.131	.174	.218	.262	.305	.349	.392	.436	.479	.528
2¼	7.0686	.049	.093	.147	.196	.245	.294	.343	.393	.442	.491	.539	.589
2½	7.8540	.051	.119	.163	.218	.272	.327	.381	.436	.490	.540	.599	.654

Outside Diameter of Flues.	Circumferences in inches.	Fractions of an Inch.													
		1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	15/16
1½	4.7124	.002	.004	.006	.008	.010	.012	.014	.016	.018	.020	.022	.024	.026	.028
1¾	5.4978	.002	.005	.007	.009	.012	.014	.017	.019	.021	.024	.026	.028	.031	.033
2	6.2832	.003	.005	.008	.011	.013	.016	.019	.022	.024	.027	.030	.033	.035	.038
2¼	7.0686	.003	.006	.009	.012	.015	.018	.021	.024	.028	.031	.034	.037	.040	.043
2½	7.8540	.003	.007	.010	.014	.017	.020	.021	.027	.031	.034	.037	.041	.044	.051

we are indebted to the "Boiler Maker." In this table the number of square feet of heating surface in tubes from 7 to 15 feet long and from 1½ to 2½ inches in diameter are given, also the same information for each inch up to a foot in length, and for the fraction of an inch. In using the table, add together the heating surface for the feet, inches and fraction of an inch for one tube and multiply by the number of tubes.



Ten-Wheel Passenger Locomotive—D. & R. G. Ry.—With Piston Valves.
Built by THE BROOKS LOCOMOTIVE WORKS.

TEN-WHEEL PASSENGER LOCOMOTIVES.

Denver & Rio Grande.

Brooks Locomotive Works, Builders.

The accompanying engraving is from a photograph of one of 10 heavy 10-wheel passenger locomotives recently built by the Brooks Locomotive Works for the Denver & Rio Grande. These engines have 21 by 26 in. cylinders, with 10-in. piston valves, and the boilers will carry a pressure of 210 pounds per square inch, which we believe is the highest pressure carried on single expansion engines in American practice. The weight in working order is 160,000 pounds, 124,000 pounds being on the driving wheels. The boiler is of the extended wagon top, radial stayed type, with a total heating surface of 2,422 square feet. The grate area is 33.5 square feet, the firebox being 109 by 41 inches. The engines have Westinghouse air pumps and tender brakes and New York driver brakes. The following table gives the chief dimensions:

Fuel	Bituminous coal
Weight on drivers	124,000 lbs.
Weight on truck wheels	36,000 lbs.
Weight, total	160,000 lbs.
Weight tender loaded	112,000 lbs.
Wheel base, total, of engine	23 ft. 7 in.
Wheel base, driving	13 ft. 0 in.
Wheel base, total, engine and tender	53 ft. 10 1/2 in.
Length over all, engine	39 ft. 11 1/2 in.
Length over all, total, engine and tender	65 ft. 10 1/2 in.
Height, center of boiler above rails	8 ft. 6 in.
Height of stack	14 ft. 11 1/2 in.
Heating surface, firebox	165 sq. ft.
Heating surface, tubes	2,257 sq. ft.
Heating surface, total	2,422 sq. ft.
Grate area	33.5 sq. ft.
Drivers, diameter	63 in.
Drivers, material of centers	Cast steel
Truck wheels, diameter	33 in.
Journals, driving axle, size	9 x 12 in.
Journals, truck axle, size	5 1/2 x 12 in.
Main crank pin, size	6 1/4 x 6 1/2 in.
Cylinders, diameter	21 in.
Piston stroke	26 in.
Piston rod, diameter	3 1/2 in.
Kind of piston rod packing	Metallic
Main rod, length center to center	9 ft. 7 in.
Steam ports, length	21 in.
Steam ports, width	2 in.
Exhaust ports, least area	50 sq. in.
Bridge, width	34 in.
Valves, kind of	Piston
Valves, greatest travel	6 1/4 in.
Valves, steam lap (inside)	1 1/2 in.
Valves, exhaust lap or clearance (outside)	0 in.
Valves, lead in full gear, negative	1/16 in.
Boiler, type of	Extended wagon top
Boiler, working steam pressure	210 lbs.
Boiler, material in barrel	Steel
Boiler, thickness of material in barrel	3/4 in.
Boiler, diameter of barrel	68 in.
Seams, kind of horizontal	Sextuple riveted
Seams, kind of circumferential	Double riveted
Thickness of tube sheets	front, 3/4 in.; back, 1/2 in.
Thickness of crown sheet	3/4 in.
Crown sheet, stayed with	Radial stays
Dome, diameter	32 in.
Firebox, length	10 ft. 1 in.
Firebox, width	3 ft. 5 in.
Firebox, depth, front	79 in.
Firebox, depth, back	68 in.
Firebox, material	Steel
Firebox, thickness of sheets	3/4 in.

Firebox, brick arch	None
Firebox, water space, width	front 4 1/2 in., sides 4 in., back 4 in.
Grate, kind of	Cast-iron rocking
Tubes, number of	326
Tubes, material	Charcoal iron
Tubes, outside diameter	2 in.
Tubes, length over sheets	13 ft. 3 13/16 in.
Smokebox, diameter	69 in.
Smokebox, length	61 in.
Exhaust nozzle	Single
Exhaust nozzle, diameter	5 1/4 in.
Exhaust nozzle, distance of tip below center of boiler	6 1/2 in.
Netting	Wire
Netting, size of mesh	2 1/2 x 2 1/2 in.
Stack	Taper
Stack, least diameter	14 1/2 in.
Stack, greatest diameter	17 1/2 in.
Stack, height above smokebox	3 ft. 7 in.

Tender.

Type	Eight wheel, steel frame
Tank capacity for water	5,500 gals.
Coal capacity	8 tons
Kind of material in tank	Steel
Thickness of tank sheets	3/4 and 5/16 in.
Type of under frame	Steel channel
Diameter of truck wheels	33 in.
Diameter and length of axle journals	5 x 9 in.
Distance between centers of journals	5 ft. 0 in.
Diameter of wheel fit on axle	6 in.
Diameter of center of axle	5 1/4 in.
Length of tender frame over bumpers	23 ft. 5 1/2 in.
Length of tank	21 ft. 8 in.
Width of tank	9 ft. 0 in.
Height of tank, not including collar	4 ft. 9 1/2 in.

THE PRESENT DEMAND FOR STEEL.

Owing to the great difficulty in obtaining steel for current needs, about 1,500 men are reported to have been laid off at Cramp's shipyard, and the result is likely to be a delay in the completion of work now in hand. In a published interview Mr. Edwin S. Cramp recently compared the consumption of steel in the building of cars and ships, and stated that the Pressed Steel Car Company uses more material at the present rate of consumption than is required by all of the shipyards in the country combined. About 3 per cent. of the country's steel output goes into ships, and the present difficulty is to secure that much. The Pressed Steel Car Company has a contract with Carnegie requiring 1,000 tons a day, and we are informed that only about 60 per cent. of that amount is now supplied.

When 18-inch I-beams, weighing 2,000 pounds each, are in such demand as to warrant their shipment by express, the condition of the steel business may be considered phenomenal. A Pittsburgh dispatch describes the situation in regard to the supply of steel shapes in that city by stating that this was actually required on a recent order, and it is safe to say that such a state of affairs in the steel business never was known before. It is not supposed that many beams of this size and weight were delivered in this way, but even one is enough to indicate the necessity of the case. The great difficulty at present is to get steel material, and particularly rolled shapes and steel castings. Immediate shipments on new orders are now practically impossible, though we have heard of cases in which offers of bonus have been made. The demand for structural steel has been increased by the fear of higher prices in the fall.

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Special Notice.—As the AMERICAN ENGINEER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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COUPLER SPECIFICATIONS AND GUARANTEES.

The recent adoption of standard specifications for couplers which are exacting enough to require good material and correct design is a step which was greatly needed and which, considering the fact that an able committee is to examine couplers on this basis with the aid of adequate apparatus, is likely to reduce the number of inferior and dangerous couplers. If the present specifications (see "American Engineer, July, 1899, page 238) are not exactly what are wanted, they may be made so as a result of experience, and it may be accepted that all that is to be accomplished by specifications may be accomplished as a result of the recent action of the M. C. B. Association. Specifications, however, will not bring about all of the results that are desired. They outline what is wanted and they furnish a measure by which to examine new and old couplers, but they alone will not encourage manufacturers to produce the best work of which they are capable.

The testing of wheels, axles and couplers is becoming a serious question because of the difficulties introduced by the necessity for destructive tests in order to show the quality of the material. Boiler steel may be safely accepted upon the success-

ful tests of coupons sheared from the edges of the sheets, but this method does not apply so well to driving and other axles, and not at all to wheels and couplers. One out of each lot of perhaps 100 is selected at random and destroyed in order to examine the quality of the others in the same consignment. This is obviously an unsatisfactory method, although it is undoubtedly the best that has been devised. It gives perhaps a fair idea of the quality of the entire order and perhaps it does not. Furthermore, unless running numbers are stamped on the individual pieces of a shipment, there is no guarantee that a condemned lot will not appear for test on a subsequent order, whereupon if the piece tested meets the specifications the whole lot would pass the second time.

It is clear that there is nothing that will take the place of inducements for manufacturers to take every precaution to turn out the best of work and service guarantees, coupled with specifications and a disposition to pay fair prices, will bring better results than are to be had in any other way. The tendency to run after low prices lies at the bottom of the coupler troubles to-day, and until the danger of this idea is realized, not even the best of specifications will avail.

The best manufacturers watch their product very closely, keeping their chemists busy with daily examinations of the metal used, and the most reliable concerns go as far as to run test bars on couplers and to test every heat of metal of which couplers are made, in order to permit of using the tensile machine as well as the chemical laboratory to keep the material up to the highest standard.

People who take this trouble and who are also willing to guarantee their couplers against wear and breakage are among the best friends that the railroads have, and for the best of business reasons they should be encouraged. Such concerns have no dread of fair specifications, but we would emphasize the fact that there are many elements which go to make good couplers which specifications will not reach. These depend on the integrity of the manufacturer, and they are very important.

DOES WINTER WEATHER AFFECT LOCOMOTIVE COAL CONSUMPTION?

"Does the temperature of the atmosphere have any appreciable effect on the amount of coal consumed by locomotives? If it does, what is the approximate per cent. of increase in coal required in the same service in zero weather over the amount necessary when the thermometer stands at 70 degrees above zero?"

This question, propounded as a subject for topical discussion before the St. Louis Railway Club, is an important one, which may or may not bring out definite figures. It will be surprising if any conclusive information is presented in the expected discussion because of the great difficulty in securing anything definite in regard to the losses of heat in locomotives while running on the road.

That there are great losses of power of locomotives in cold weather is proven by the material reduction of train loads. Most recent methods for the rating of locomotives are provided with special reductions to be used in making up trains in cold weather, and these vary from 10 to 20 per cent. The recent tests of boiler coverings made on the Chicago & Northwestern directed attention to the desirability of extending the ordinary coverings of boilers to the exposed surfaces of the fireboxes, and that road now covers its fireboxes with lagging so arranged as to protect the surfaces from a large part of the radiation and at the same time the stay bolts are not rendered inaccessible for inspection and repairs.

The firebox surfaces undoubtedly need to be covered, but the heat insulation should not end there, because there is probably a much more serious source of loss than that from the water legs of the boiler when the locomotive is rushing through an atmosphere of low temperature.

It was noticed that the application of heat insulating lagging to cylinders on the Chicago & Northwestern, several

years ago, made an appreciable effect upon the power of locomotives in their winter ratings, and this practice points at once to the very important losses of heat through the cylinder walls. We have taken the position that not only should the cylinders be protected, but also the saddle castings through which the steam must pass on its way to the cylinders, and which are in the most exposed part of the engine. It is well known that water coming into the cylinders during the admission of steam not only affects the economy of the engine adversely, but it also reduces the power of the engine to a considerable extent, and one way to reduce this condensation is to guard as far as possible against the loss of heat of the steam on its way through the saddle castings. It would be easy to improve in this direction, and it is strange that it has not already become common practice.

It is to be hoped that this question will receive attention in the discussion expected from the introduction of this topic. It is important to know the proportion of loss of power in winter, but it seems to be more important to discuss possible ways for reducing the losses, which are known to be large, especially when it must be admitted that the proportion is almost impossible to ascertain.

PENNSYLVANIA RAILROAD PENSION SYSTEM.

The Pennsylvania Railroad has decided to establish a system of pensions and will provide a superannuation fund for the benefit of employees. This example is worthy of being followed, and we hope that one result of the present excellent condition of business will be an increased attention to the duties of the companies to their men. The manner of American railroad development was such as to crowd such questions as this into the background, for the reason that many of the roads have had a continuous struggle to keep out of the hands of the courts, but it is beginning to be recognized that railroad service may be greatly improved by giving the men reasons for desiring to retain their situations. The schemes of urging employees to purchase their homes and to secure shares of stock of the road tend in this direction. Men with responsibilities must be steadier and more valuable to their employers and also more successful from their own point of view than those who feel little hesitation in changing about. There can hardly be a better check against this floating tendency than the pension or superannuation fund, which insures a faithful and competent employee a living after he is too old to work. The prospect which such a plan holds out to a man must necessarily prove a strong influence, which will in the majority of cases result in a net gain to the company, even when viewed only on its commercial side. The pension system may be expected to insure a steady, contented lot of men, who respect their "company," but it need not deaden ambition or retard progress—if the requirements are high. This idea and the system of discipline without suspension have many points in common, and the latter may prove to be an entering wedge for the former.

Many roads have now begun to find their men growing old and the problem is: What to with them. They cannot earn enough to warrant continued employment, and yet they have served their employers faithfully for perhaps thirty and more years. During all these years they should have been saving against the future, but whether they have done so or not, there is a clear obligation on the part of the employer to provide for them in a way which shall not resemble charity, but shall partake of the idea of reward for long and faithful service in work which is usually both responsible and exacting.

The Pennsylvania is providing for about 75,000 men and will require about \$325,000 as an annual outlay. Employees between the ages of 65 and 70 years who have served the company 30 years will be allowed to retire from active service, or they may be retired by the management of the fund. The age when retirement is compulsory is 70 years, and the pension paid will be proportional to the average wages paid each em-

ployee during a certain number of years, which does not necessarily cover the entire time of service, and an additional allowance will be paid out of the interest on the surplus of the Relief Fund, the amount being based upon the payments which they have made while members of that organization.

It is understood that the pension plan will go into effect at the beginning of next year, the number of pensioners being 775, 672 of these will be over 70 years of age at that time. There are now 3,000 men in the service who are over 60 years old; there are 50 who are over 80 years, and 99 men employed on the Delaware & Raritan Canal have been in the service over 45 years; one has worked for the company 63 years and another 61 years. An accompaniment to the pension plan is a new rule to the effect that no one over 35 years will be taken as a permanent employee, and those taken will be required to pass a physical examination. The pension fund is in the hands of a committee of officers of the company, and its privileges will be offered to employees without regard to the membership in the Relief Fund.

This scheme has been very carefully considered, with a view of the best interests of the company, as well as those of the men. It is to be hoped that the future will find many railroads in position to follow this example. They will undoubtedly take the question into consideration when it is possible, and there seems to be no doubt of the appreciation of the employees. One result which may be expected is a diminution of anxiety in regard to labor difficulties.

A smoke consuming or smoke prevention system has been developed in Berlin, Germany, very satisfactory results being reported by Consul General Mason. The system employs ordinary grate bars alternated with hollow ones perforated to distribute air to the fire from a fan blower. The air is heated in a manifold before passing into the hollow bars and it issues into the fire in the form of highly heated jets. It has been demonstrated that low grades of fuel may be burned by this form of grate without smoke. It is patented in the United States by Paul Cornelius of Berlin. Patent No. 613,359.

The successful replacement of the Passaic River drawbridge of the Pennsylvania Railroad, near the Market Street Station, Newark, N. J., in a remarkably short time is worthy of record. The old bridge had been in use 30 years and was too light for present day requirements. The new span, 213 feet long, was built by the Edgemoor Iron Company and erected near the old span. The old draw span was raised by jacks and drawn out of the way and replaced by the new one in 18½ minutes, although the bridge was out of service for a longer time. The work was entirely successful, credit for the plans and execution being due to Messrs. G. B. Beale and L. H. Barker, engineers of the Pennsylvania. The work was done Sunday, July 23. The new span weighs about 600 tons and the old one 400 tons. As they were coupled together when moved, the load was about 1,000 tons.

The remarkable fast time on the Vandalia, made by one of the new Schenectady 8-wheel passenger locomotives, was briefly noted last month. We have just received particulars of several other runs which, in view of the weight of the trains, are specially noteworthy. Mr. H. I. Miller, Superintendent of the Vandalia, writes that engine No. 16 hauled train No. 20, July 14th, from Clayton to Transfer Station, 18 miles, in 18 minutes. The train consisted of two postal cars, one combined coach and baggage car, eight coaches, one dining car and two sleepers, 14 cars, weighing 548.2 tons and carrying 460 passengers. The same locomotive hauled train No. 20 the next day between these stations in 16 minutes, the train of 13 cars consisting of two postal cars, one combined coach and baggage car, seven coaches, one dining car and two sleepers, weighing 500.8 tons. These weights do not include the locomotive, which weighs 139,000 pounds. The train on the 20th ran from Coatesville to Transfer Station, 26 miles in 26 minutes.

PERSONALS.

Mr. Frank Cain, Master Mechanic of the Texarkana & Fort Smith, has resigned.

Mr. N. W. Best has been appointed Superintendent of Motive Power and Machinery of the Los Angeles Terminal Railway.

Mr. W. Richmond has been appointed Master Mechanic of the Lake Shore & Ishpeming, with headquarters at Marquette, Mich.

Mr. R. E. McCuen, General Foreman Lexington & Eastern, has been appointed Master Mechanic, with office at Lexington, Ky.

John Torrance, Superintendent of Motive Power and Rolling Stock of the Evansville & Terre Haute, died at Evansville, Ind., on August 2.

Mr. Isaac Seddon has been appointed Purchasing Agent of the Chicago, St. Paul, Minneapolis & Omaha, to succeed Mr. W. H. S. Wright.

Mr. J. E. Capps, Foreman Car Repairs Georgia Southern & Florida, has been given the title of Master Car Builder, with headquarters at Macon, Ga.

Mr. F. W. Williams has been appointed Division Master Mechanic of the Delaware, Lackawanna & Western at Syracuse, to succeed Mr. L. Kistler, resigned.

Mr. Joseph Buker, Superintendent of the Consolidated Cattle Car Company, has been appointed Assistant Superintendent of Machinery of the Illinois Central.

Mr. L. B. Rhodes, Foreman of the machine shops of the Georgia Southern & Florida, has been appointed Master Mechanic, with headquarters at Macon, Ga.

Mr. H. A. Webster has been appointed Master Mechanic of the Manhattan Railway, in charge of the mechanical and car repair departments, which have been consolidated.

Mr. P. G. Cauton has been appointed Purchasing Agent for the Yucatan Southeastern Railroad, a new road to be built in Yucatan. His office is at 29 Broadway, New York.

Mr. Philip Wallis, Master Mechanic of the Lehigh Valley at Easton, has been appointed to succeed Mr. Samuel F. Prince as Superintendent of Motive Power of the Long Island Railroad.

Mr. A. C. Loucks, formerly Traveling Engineer, has been appointed Acting Master Mechanic of the Missouri, Kansas & Texas, at Denison, Tex., to succeed Mr. T. C. McElvaney, resigned.

Mr. Joseph W. Taylor, Secretary of the American Railway Master Mechanics' Association and the Master Car Builders' Association, has changed his address to Room 667 The Rookery Building, Chicago.

Mr. J. A. Edson has been appointed General Manager of the Kansas City, Pittsburgh & Gulf, the Texarkana & Fort Smith and the Kansas City, Shreveport & Gulf Railways, to succeed the late Robert Gillham.

Mr. Howard James has been appointed Purchasing Agent of the Great Northern Railway to succeed Mr. S. F. Forbes, re-

signed. Mr. James was formerly Purchasing Agent of the Northern Steamship Co.

Mr. W. E. Chester, general foreman of the Central of Georgia, at Columbus, Ga., has been promoted to the position of Master Mechanic, to succeed Mr. J. L. Whitsitt, who has been transferred to Savannah.

Mr. Amos Turner has been appointed Division Master Mechanic of the Lehigh Valley at South Easton, Pa., to succeed Mr. Phillip Wallis, resigned. Mr. Turner was formerly General Foreman of the shops at Easton.

Mr. C. Graham, Jr., has been appointed Division Master Mechanic of the Delaware, Lackawanna & Western, in charge of the Buffalo and Cayuga Divisions, with headquarters at East Buffalo, to succeed Mr. F. B. Griffith, resigned.

Mr. Robert O'Brien has been appointed Master Mechanic of the Atlantic Coast Line, with headquarters at Richmond, Va., to succeed his father, Mr. John O'Brien, who has been appointed General Fuel Clerk at Manchester, Va.

J. G. Tomlinson, Superintendent of Motive Power of the New Orleans & Northeastern, was run over by a locomotive and killed at Meridian, Miss., July 25. He was connected with the Queen & Crescent system for more than 15 years.

Mr. T. W. Demarest, Roundhouse Foreman of the Pennsylvania Lines at Indianapolis, Ind., has been appointed Master Mechanic of the Logansport division, with headquarters at Logansport, Ind., to succeed the late W. C. Pennock.

Mr. H. C. McCarthy, for a number of years connected with the Pennsylvania as Chief Inspector of the Northern Central at Williamsport, Pa., has resigned and accepted an appointment as Mechanical Expert of the Galena Oil Company.

Mr. W. G. Noxin, Chief Clerk of the Purchasing Department of the Missouri Pacific, has been appointed Purchasing Agent, with office at Saint Louis, to succeed Abram Gould, deceased. Mr. George Snodgrass has been appointed Assistant Purchasing Agent.

Mr. James K. Brassill has resigned as Assistant Master Mechanic of the Chicago, St. Paul, Minneapolis & Omaha, at Sioux City, to accept the position of Master Mechanic of the California Northwestern at San Francisco. He will have entire charge of the motive power department, including floating equipment.

Mr. E. B. Thompson has returned to the Chicago & Northwestern Ry. to succeed Mr. F. M. Whyte as Mechanical Engineer of that road. Mr. Thompson held this position for a number of years until his appointment to a similar position on the Northern Pacific about two years ago under Mr. E. M. Herr, then Superintendent of Motive Power.

Mr. L. L. Smith, Foreman in the Motive Power Department of the Burlington at Streator, Ill., has been appointed Master Mechanic of the Northwestern Division of the Chicago Great Western, with office in St. Paul. He succeeds Mr. David Van Alstine, who was recently promoted to the position of General Master Mechanic. Mr. Smith has the advantage of a technical education added to excellent experience in the mechanical department of the Burlington. He has made a specialty of the application of piece work to locomotive shops, and for several years was in charge of the interesting brass foundry at Aurora. At that time he prepared for us the paper on the manufacture of phosphor bronze printed on page 147 of our May issue.

Mr. Theo. H. Curtis, Mechanical Engineer of the New York, Chicago & St. Louis, has resigned to become Mechanical Engineer of the Erie, with headquarters at Susquehanna, Pa. Mr. Curtis entered railroad service at Terre Haute in the office of the Superintendent of Motive Power of the Terre Haute & Indianapolis. He took pains during the next few years to learn mechanical railroad work in all of its branches, including the shop, the drafting room and the office of Superintendent of Motive Power. He has also been connected with the Brooks Locomotive Works and the Pittsburgh Locomotive Works. In 1890 he was made Chief Draughtsman of the New York, Chicago & St. Louis, and several years ago was promoted to the position of Mechanical Engineer. He has designed and patented several locomotive improvements.

Mr. Guy E. Mitchell, for a number of years Chief Draftsman in the Motive Power Department of the Boston & Maine, has been appointed Mechanical Engineer and Superintendent of the Locomotive Smoke Preventer Co. of New York, of which Mr. Albert Freeman, 203 Broadway, is General Manager. Mr. Mitchell is a graduate of the Massachusetts Institute of Technology. He began in the shops of the Boston & Maine after graduation and soon after was placed in charge of the drawing room. He worked out the details of the Concord shops of that road, which we illustrated fully last year, and has had charge of other important mechanical engineering work. He is well qualified to improve the combustion of coal in locomotive fireboxes and is a valuable acquisition to the new company whose services he now enters. His successor on the Boston & Maine is Mr. Carl Smith.

Mr. F. M. Whyte has resigned as Mechanical Engineer of the Chicago & Northwestern to accept a position with the same title on the New York Central. He will have charge of the mechanical engineering of the motive power department, including the drafting and experimental work and the testing of materials, both mechanical and chemical. Mr. Whyte is well qualified for the position and the appointment is heartily commended. His experience has been gained in the mechanical department of the Baltimore & Ohio and the Chicago & Northwestern. He was associated with the late David L. Barnes in consulting mechanical engineering work in Chicago, and after the death of Mr. Barnes he opened an office as consulting engineer in that city. Mr. Whyte is widely known from his excellent work as Secretary of the Western Railway Club during the past two years. He appreciates the importance of motive power and car questions and is one of the young motive power officers from whom a great deal may be confidently expected.

MCLAUGHLIN'S FLEXIBLE METALLIC STEAM CONDUIT.

This steam pipe connection was developed on the Boston & Maine R. R. by Mr. M. P. McLaughlin for the purpose of avoiding the difficulties of the use of rubber hose in steam connections between locomotives and cars. Rubber hose was very expensive to maintain on account of its short life, and the metallic connection has proved entirely satisfactory after having been in service for two years. An illustrated description of the construction of this conduit was printed on page 376 of our issue of November, 1898. At that time it was in use on the Boston & Maine, but as it has since been put into service on the Chicago & Northwestern, the "Rock Island," the Union Pacific, the New York, Chicago & St. Louis and the Chicago, Milwaukee & St. Paul, it appears to be worthy of further notice.

The joints in the pipe, which is made of steam metal, are made by swiveling elbows, which are packed with vulcanized rubber washers large enough to keep the joints tight and also to provide for taking up wear. There are no springs or loose parts and no ball joint surfaces to maintain. While adapted to a number of purposes requiring flexible connections, such as the hydraulic locomotive hoist at the Boston & Maine shops at Boston (see "American Engineer," May, 1899, page 166), the

most severe test has been made in connecting locomotives and tenders for steam heating. It shows itself to wear well without leaking and any form of couplings may be attached to it. It has been found necessary to attach some forms of metallic conduits very nearly in line with the draw bar connection, but we are informed that this is not necessary with the conduit under notice. Interesting and valuable experience was reported concerning a certain form of metallic steam conduit at the recent convention of the Master Mechanics' Association, a portion of which, applying to all forms of flexible metallic conduits, we reproduce as follows:

The Comparative Efficiency and Economy of Metal Flexible Joints Versus Rubber Hose for Steam-heating Connections.

Mr. A. W. Gibbs (Pennsylvania R. R.).—I have availed myself of some records of flexible joints, which we began to use about 1892. At that time the maintenance of connections between our engines and tenders became troublesome, on account of the oil which was thrown from the driving wheels, and it gave us a great deal of trouble by destroying various kinds of flexible hose which were not adapted to resist the action of oil and heat. We finally adopted flexible metal joints, which we now use wherever we have to convey steam between engines and tenders. I find that since 1893 we have bought about 2,900



McLaughlin's Conduit—South Union Station, Boston.

joints, for 750 engines altogether, being equipped on all of the lines. There appear to have been about 25 failures from various causes. These joints are now used entirely for the purpose mentioned, partly because they resist the action of oil, which destroys other material, partly because there is no possibility of bursting, which is very awkward on a through train, where you cannot afford to stop, and partly because in our steam heating system we have to carry very heavy pressures between the engine and tender, in order to operate a vacuum pump. Ordinarily you do not have to carry much more than 40 lbs., unless you are running a dynamo in the baggage car; but we are practically running a separate engine all the time on our passenger trains, because we have a vacuum pump in our tender. While the first cost is greater, there are places where you cannot afford to have a failure even at the expense of greater first cost; that is, you can afford to pay a considerable amount to avoid failures in certain important places.

Mr. Frank Slater (Chicago & Northwestern).—My experience has been somewhat limited as to the number of these joints in use. The experience we have had has been very favorable. We have had no expenses connected with the joints when properly applied in the first place. In the first engine on which the joints were applied they were placed considerably to the side of the engine, making a great deal of motion when

rounding curves, and they wore out in about six months. Since then they have been placed directly in line with the drawbar, and they show no wear to speak of, and I have every reason to believe they will last a long time.

Mr. A. E. Manchester (Chicago, Milwaukee & St. Paul).—We commenced last fall applying the ——— joint to a number of our passenger engines that haul dynamo trains. We had had a great deal of trouble with hose connections due to the high pressure steam and the excessive motion, with our overhead system between the engine and tender. The experience thus far has been entirely satisfactory with the ——— joint. We have had no failures whatever, and there have been no cases of leakage. We are putting on more of the joints. The question of cost is considerable when compared with the hose connection, but after looking over our record of cost to maintain the hose connection, we came to the conclusion it would be a very good investment. We found that with dynamo trains we were using about 7 or 8 hose a year, to maintain the service between the engine and tender, with occasional delays occurring on the road by the failure of the steam. We believe the ——— joints are very satisfactory. The joints come recommended in such a way that we get a three years' guarantee on them, which of itself is something of an object.

The accompanying engraving was made from a photograph illustrating the application of the flexible metallic conduit to each of the 50 bumper posts in the new South Union Station in Boston. We are informed that this conduit was selected for this purpose as a result of a thorough test of all similar devices now available. It has been applied to each of the 50 tracks which are equipped for heating cars, while standing in the station, and will be used for warming up the cars before the locomotives are attached. The photograph shows the form of the post and the location of the conduit. For the details of the construction of the conduit and its joints the reader is referred to the previous description. Its selection for use at the Boston station is a substantial endorsement.

COST OF HANDLING FREIGHT.

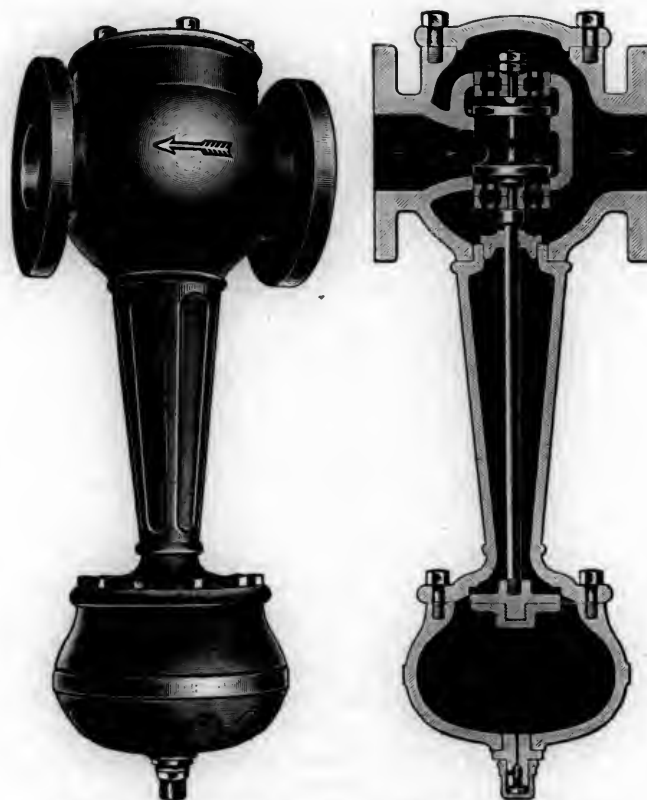
In a recent discussion of the possibility of reducing the cost of handling tonnage, says the "Railway World," General Manager Ramsey, of the Wabash, who is one the most conspicuous advocates of better car loading, remarked that "to increase the trainload you must either increase the weight and power of your engines or decrease your grades. The best way probably is to do both." Both in theory and in practice, however, Mr. Ramsey is striving zealously to realize a third alternative—that of adding very materially to the average amount of freight in each loaded car. The average number of tons freight in each loaded car in each of the last two years on fifteen lines was as follows:

	1898.	1897.
New Haven.....	9.43	9.34
Erie	14.84	13.94
Southern	11.46	12.30
Louisville and Nashville.....	13.89	13.16
Illinois Central.....	12.69	12.51
Wabash	12.99	12.86
Lake Shore.....	15.41	14.34
Rock Island.....	15.96	14.46
Northwestern	12.05	10.39
St. Paul.....	10.94	10.74
Omaha	13.97	13.08
Great Northern.....	14.75	14.18
Northern Pacific.....	12.21	10.05
Missouri Pacific.....	12.50	12.20
Kansas and Texas.....	11.94	11.71

These averages, of course, are determined by two or three principal factors, such as the prevailing character of the traffic, the physical features and the equipment of the line and the quality of the management. The fact of chief interest is that those representative companies, with a single exception in the last year, helped out their train loads and saved train and car mileage by increasing their carloads. The most striking gains were those of the Northern Pacific and the Chicago & Northwestern.

AIR SPRING PRESSURE REGULATOR.

This device is a pressure regulator or reducing valve which, instead of employing a spring to regulate the pressure, makes use of an air cushion confined in a casing attached to the lower part of the valve. The engraving makes the construction of the device clear. The movement of the valve and consequently the regulation is effected by the pressure of air in the bulb at the bottom of the valve, the pressure being obtained by means of an ordinary bicycle pump. The valve is supported on a flexible metallic diaphragm connected to the valve by a vertical spindle. The air pressure opens the valve and holds it open until the low pressure on the other side of the diaphragm becomes great enough to force it to its seat again. In this way any desired pressure may be secured uniformly by pumping the desired amount of air into the air spring chamber. The valve is double-seated and the device has the advantage of pressure upon both sides of the diaphragm. It is obvious that the fitting for the reception of the pump attachment may be placed at a distance from the air chamber and piped to it if this is desirable on account of the valve being placed in an in-



Air Spring Pressure Regulator—D'Este & Seeley Co.

accessible position. The valve is fitted with mufflers and it is stated that its operation is noiseless. This device is manufactured by D'Esté & Seely Co., 29 Haverhill Street, Boston, who state that they have tested it for two years with marked success.

USING THE TECHNICAL PAPERS.

In his presidential address before the Master Mechanics' Association, Mr. Robert Quayle, Superintendent of Motive Power of the Chicago & North Western Ry., directed attention to the use of the technical papers. His idea is an excellent one. "We should use the technical papers intelligently. It is a good plan for the head of the motive power department to mark articles and send them to their master mechanics and such other employees as they would deem wise, asking for comments and suggestions. Will not a little work in this direction pay well?" Sensible advice in the same direction is given to young engi-

neers by Mr. Daniel Royse in a recent contribution to "The Purdue Exponent," from which the following paragraphs are taken:

"If a young engineer is so situated that he can contribute to the technical press as a writer in either of what are here called the first two classes, it will be of distinct advantage to him to do so. He acquires the ability to express himself well; he learns to think straight (or he is quickly found out); he will become known to his future clients. The discussion which may arise on the subject will be at comparatively short range; because publication is not delayed for weeks or months; an inexperienced writer is given a better chance to consider any reply to questions and criticism than is offered in oral debate at a society meeting; moreover, the men who take part in such discussions do so because they are interested in the subject. Lastly, the pecuniary reward is not to be despised.

"As a preparation for his future work a young engineer cannot do better than to become a close reader of the current periodicals which have for their field his chosen profession. Let him follow the discussions and if possible take part in them; in order to do this with credit to himself, he must become familiar with the subject, and having once mastered it will easily recognize it when after a period of eight or ten years that same subject appears again thinly disguised and heralded as something that is really new. Many questions have a way of reappearing at more or less regular intervals, so that the elders of the profession have met most of them more than once."

TEST OF AN OTTO GASOLINE ENGINE.

Prof. L. P. Breckenridge recently made a test of a 10-horse power Otto gasoline engine at the University of Illinois, the results of which are given in the accompanying table and text, for which we are indebted to the "Railroad Gazette." Four tests were made with the engine belted to a Curtis tank pump, being the arrangement commonly used at railroad water stations; in fact, the test was made especially to determine the performance of the Otto engine under conditions similar to those at water stations. One test was also made in which the work of the engine was absorbed by a brake. The results as shown by the following table are unusually consistent:

Date.	May 30, 1899.			June 1, 1899.		
With pump or brake.	Pump.	Pump.	Pump.	Brake.	Pump.	Pump.
Duration of test, hours.....	2	11 1/3	1 1/2	1 1/2	1 1/2	1 1/2
Indicated horse-power.....	3.63	3.74	4.65	12.15	4.45	4.45
Theoretical horse-power required to pump water.....	0.742	0.896	1.24	*10.52	0.96	0.96
Theoretical horse-power required to pump water in per cent. of i. h. p.....	20.47	23.96	26.67	*86.56	21.57	21.57
Temperature of | Before.....	68	69	68.8	63.6	69	69
Jacket water. Deg. F. | Af.....	117.3	118.6	117.3	118.5	120	120
Temperature of | Room.....	84.5	86.1	88	86.4	86.5	86.5
air. Deg. F. | External.....	79.3	80.9	81	80.6	82	82
Temperature of exhaust, Deg. F.	405	416	466	796	461	461
Jacket water, lbs., used per hour	270	342.6	307.2	836	306	306
Engine, rev. per min.....	309	308.4	309	307	309	309
No. explosions per min., average	50.9	49.5	57.1	148.3	58	58
Pump, rev. per min.....	57.0	54	53	....	54	54
Head pumped against, ft....	22.7	28.1	41.1	....	30	30
Water pumped per hr., gals.	7,760.4	7,546.4	7,151.6	....	7,588.2	7,588.2
Gasoline used per hr., gals..	0.534	0.54	0.57	1.183	0.508	0.508
Water pumped per gallon of gasoline, gals.	14,533	13,875	12,547	....	14,935	14,935
Gasoline per i. h. p. hr., gals.	0.147	0.144	0.122	0.097	0.114	0.114
Gasoline per b. h. p. hr., gals.	....	....	....	0.112	....	....

*Brake horse-power.

**Mechanical efficiency = brake horse-power ÷ indicated horse-power.

†Includes suction lift.

It may be noticed that in the pump tests the mechanical efficiency given is that of the whole plant, taking account of the resistance of the engine, pump and ram, and the pipe friction. The consumption of gasoline per hour in the several tests is seen to vary nearly as the power developed, indicating that the efficiency of the engine is not seriously impaired when working under light loads. The speed in the several tests was maintained fairly constant. Since the tests, this engine has been used by the University to drive a generator which furnishes current for electric lights, and we are informed that the engine is found well adapted to such work.

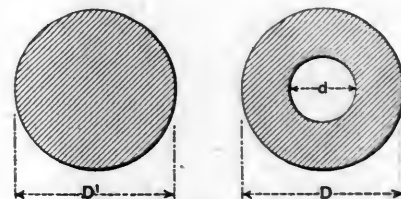
SHAFTS, HOLLOW AND SOLID.

The appended table of constants, which is reprinted from an issue of "The Engineer" of London, of several years ago, will be found worthy of preservation by those who have to deal with questions relating to the strength and dimensions of shafts. The figures permit the ready determination of equivalent solid and hollow shafts of any dimension, and thus simplifying calculations for strength, deflection, etc., as the ordinary and more general formulæ for solid shafts can be used and the equivalent hollow shaft determined from the required solid one by use of the constants: thus, suppose we are designing a shaft for a given case, which we estimate requires to be 13 inches diameter if solid, and it is desired to reduce weight by making it hollow, then, for a reduction of about 25 per cent. the ratio

Inside diameter
Outside diameter (or x in the table) will require to be 0.5.

Estimating on the solid shaft, which will be found sufficiently accurate for reductions of weight up to about 30 per cent. thus our 13-in. shaft has a cross sectional area of 132.7 square inches, 25 per cent., of which = 33.2, the area of a 6 1/2-in. diameter hole, so that for a reduction of about 25 per cent.

$\frac{d}{D} = \frac{6.5}{13} = 0.5$, the error due to this method being in the present example under 1 per cent. Then from the table, op-



Hollow and Solid Shafts.

posite $x = 0.5$ in the first column read off the corresponding value of $C = 1.0218$ in the second column, and 13-in. $\times 1.0218 = 13.2834$, say 13 5-16-in will be the required outside diameter of the hollow shaft with a hole say, 6 11-16-in. diameter. Again, suppose the given shaft to be hollow, say 12 1/2-in. external diameter, bored 5%, then $x = 0.45$ the value of K corresponding to which is found in the third column of the table to be 0.986, therefore the diameter of an equivalent solid shaft would be $12.5 \times .986 = 12.225$ -in.

Let D^1 = the diameter of a given solid shaft, D the outside, and d the inside diameters respectively of an equivalent hollow shaft; also let $D \times x = d$.

Then $D = D^1 \times C$ and $D^1 = D \times K$, the values of C and K being given in the following table for known values of x . (Calculated by Geo. R. Bale).

x or $\frac{d}{D}$	C or $\frac{1}{1-(x)^4}$	K or $\frac{D^1}{D}$	x	C	K	x	C	K
0.80	1.1919	0.8382	0.59	1.0440	0.9578	0.39	1.0079	.9920
.79	1.1789	.8482	.58	1.0409	.9607	.38	1.0069	.9930
.78	1.1666	.8571	.57	1.0382	.9632	.37	1.0063	.9931
.77	1.1553	.8656	.56	1.0354	.9660	.36	1.0056	.9940
.76	1.1452	.8732	.55	1.0326	.9684	.35	1.0049	.9951
.75	1.1352	.8809	.54	1.0301	.9707	.34	1.0043	.9958
.74	1.1263	.8873	.53	1.0278	.9729	.33	1.0040	.9960
.73	1.1178	.8946	.52	1.0256	.9751	.32	1.0036	.9962
.72	1.1100	.9009	.51	1.0237	.9768	.31	1.0033	.9965
.71	1.1027	.9068	.50	1.0218	.9786	.30	1.0026	.9971
.70	1.0958	.9125						
.69	1.0897	.9176	.49	1.0202	.9802	.29	1.0023	.9973
.68	1.0835	.9229	.48	1.0183	.9820	.28	1.0021	.9977
.67	1.0779	.9277	.47	1.0170	.9834	.27	1.0019	.9980
.66	1.0729	.9321	.46	1.0154	.9848	.26	1.0016	.9983
.65	1.0678	.9365	.45	1.0141	.9861	.25	1.0013	.9987
.64	1.0632	.9405	.44	1.0128	.9873			
.63	1.0589	.9444	.43	1.0115	.9886			
.62	1.0549	.9480	.42	1.0105	.9896			
.61	1.0510	.9514	.41	1.0099	.9901			
.60	1.0474	.9546	.40	1.0089	.9910			

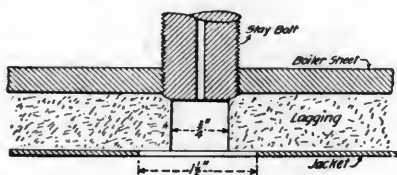
FIREBOX LAGGING FOR LOCOMOTIVES.

Chicago & Northwestern Railway.

The results of the elaborate tests of the efficiency of different locomotive boiler coverings made last winter on the Chicago & Northwestern Railway ("American Engineer," March, 1899, page 76), made such a favorable showing for the general practice of covering about 61 per cent. of the exposed surface with lagging, as to lead to an extension of the covering to the sides and throats of boilers having narrow fireboxes. The advantages of this were obvious, but the difficulty was to provide for the necessary inspection of the stay bolts.

All of the staybolts are drilled with tell-tale holes and wire nails of suitable length are inserted in these holes, after which the sides and throat of the firebox, below the running board, are covered with a plastic covering about $\frac{1}{2}$ or $\frac{5}{8}$ inch thick, taking care to have it fit the sheets closely. When this has dried sufficiently the ends of the staybolts are exposed by cutting out the lagging opposite each bolt by means of a circular punch about $\frac{3}{4}$ inch in diameter. The nails inserted in the holes serve to locate the bolts.

The jacket is of sheet steel about $\frac{1}{16}$ inch thick, and it is perforated with holes opposite the staybolts, as shown in the tlicable in order to cover as much surface as possible, and those in the jacket are made larger in order to facilitate the sketch. The holes in the lagging are made as small as practicable on each side and one at the throat. The throat and side sheets are lapped over each other at the front corners of the firebox. The jacket is held in position by a number of $\frac{1}{2}$ -inch



Firebox Lagging—C. N. W. Ry.

bolts placed about 16 inches apart. Care is taken to make the jacket fit the lagging as closely as possible.

In this way probably about 80 per cent. of the entire surface of the boiler is protected against radiation, and, according to the tests referred to, this should effect a respectable saving in coal. It was found that when the lagging was extended to the back heads of the boilers the men found the cabs too cold in severe weather, and parts of it were removed. It should be possible to cover the back heads for warm weather and remove enough of the lagging to properly heat the cabs in winter.

We would like to record a plan for lagging the cylinder saddles, and hope this will be the next advance step in this line.

FLANGED VS. "BALD" DRIVING WHEEL TIRES.

One of the many features of locomotive practice on which the opinions of well-informed men is divided is the necessity for omitting the flanges of the middle pair of wheels of a ten-wheel locomotive, and of the second and third pairs of drivers of the consolidation type. The present tendency is toward the use of flanges on all driving wheels, and making an allowance for a little more end play on the journals. A number of roads have discarded plain or "bald" tires altogether and apparently without any sacrifice. The reason is a desire to avoid the expense and trouble incident to carrying plain tires of several sizes in stock. It was regularly practiced in 1860, or thereabouts, by the Rogers Locomotive Works, and the conditions of that time were such that we may raise the question as to why flangeless tires were ever used, even when the 10-wheel and consolidation types came into use. The Master Mechanics' Association has considered this subject several

times, and at its most recent appearance at the June conventions of this year the light of present practice was thrown on it by Mr. Henderson and Mr. McConnell.

The former stated that several years ago there were some 10-wheel passenger engines on the Norfolk & Western with bald tires in front and two or three arrangements of trucks for swinging or stationary centres. "We found," said Mr. Henderson, "that rigid trucks seemed to meet with a good deal of a blow when the engines struck a curve. We then changed to swinging centres, and they went around the curves nicely, but there was a good deal of side motion. The restricted swing seemed to be the best arrangement of all. We found the engines would curve more readily and yet the swaying motion would be almost absent, so that a truck with a spring to hold a swing or free centre hanger, to return it very quickly, seemed to be the best arrangement. These arrangements were made with engines having bald tires in front, but later there was some change and flanged tires put in front. American type of engines, 8-wheelers, have been run on a good many roads with swinging centre trucks and flanges on the main wheels; and the 10-wheel engine is not very much different. If we expect to do the guiding by the truck, it is furthest ahead and has the longest lever, and it would seem to be the best place to do the guiding. The truck, so much further ahead, has a longer lever arm, and will receive less resistance than if we put flanges on the front pair of drivers."

The Rome, Watertown & Ogdensburg, the Lehigh Valley, Southern Pacific, Oregon Railway & Navigation Co., Chicago & Western Indiana, Union Pacific, Kansas City, St. Joseph & Council Bluffs and the St. Joseph & Grand Island have, according to Mr. McConnell, all given up the plain tire on 10-wheel, consolidation, and 6-wheel switching types. Mr. McConnell said:

"On the Union Pacific road for the past three years it has been the practice to apply nothing but flanged tires on our consolidation, 10-wheelers and switching engines. The consolidation engines are running on grades of 90 feet to the mile, with a maximum curve of 10 degrees. Our switching engines in the yard are working over 22-degree curves. It is our practice on the consolidation engines to set the two middle tires a total of 3-16 of an inch closer than we do to the front and the back tires. We follow the same practice on the 10-wheelers and on the 6-wheel switching engines. Our experience has been that we have less wear on the front and back tire than we did when the two middle wheels on the consolidation and the middle wheel on the 10-wheeler were bald. The Burlington & Missouri road purchased some consolidation engines last year for service on the Black Hills line. I believe they have grades of 3 per cent. and curves of over 16 degrees. They found that the flanged tires on these engines were a little unsatisfactory and they were obliged to change them, but on the other portions of the road they give very satisfactory service. The advantages, aside from the wear of the tire is that it requires to carry only one class of tire, and that is a flanged tire. On all our engines, as they come to the shop, where they have a blind tire, we turn them up so as to apply a flanged tire."

The use of graphite as a lubricant of engine cylinders is becoming common enough to attract attention to this method of reducing the friction of engines and economizing in the use of oil. The finely ground graphite may be introduced by means of the regular sight feed oil lubricator, or it may be introduced by a small hand pump. We have received records showing a reduction of 12 per cent. in the internal friction of a refrigerating machine obtained by using a hand pump to inject a mixture of oil and graphite into the steam pipe and using a small amount of the same lubricant on the bearings. A saving of 75 per cent. in oil is reported for this plant as a result of the use of graphite. Lubricators are now made which will feed graphite automatically and continuously with the desired uniformity and pass the lubricant through a sight feed glass.

THE "A. B. C." JOURNAL BEARING.

The purpose of this new bearing, which is manufactured by the Atlantic Brass Co., 192 Broadway, New York, is to provide means for transmitting the load to the journals uniformly throughout the length of the journal in order to prolong the life of the brass and prevent heating. To accomplish this the load is transmitted from the box to the brass through a "wedge," which has an adjustable contact with the brass, the surfaces of contact being such as to permit the brass to load the journal uniformly in spite of the tilting and transverse movements of the box.

In the M. C. B. box no provision for self-adjustment is made and the lives of brasses are often very short, because of a con-

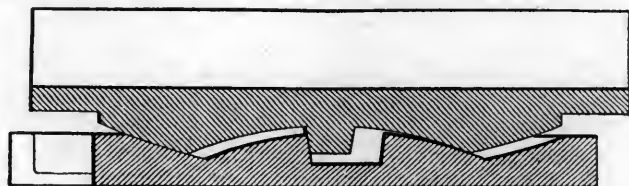


Fig. 1.

centration of the load at or near one point. This is sure to occur when the truck frame tilts even slightly, and its effect is seen in examining M. C. B. brasses, which very seldom wear uniformly throughout their length.

The engravings show the self-adjusting surfaces which are ingeniously arranged. The brass has a cavity in the center of its upper face, into which a segment of a sphere on the under side of the wedge fits. The cavity in the brass is slightly elongated for the purpose of giving an easy adjustment of the wedge and the brass. Other spherical surfaces outside of those at the center help to carry the load, and as shown in Fig. 1, they cause the wedge to rise on the top of the brass when subjected to side thrusts, and even under these thrusts the load is

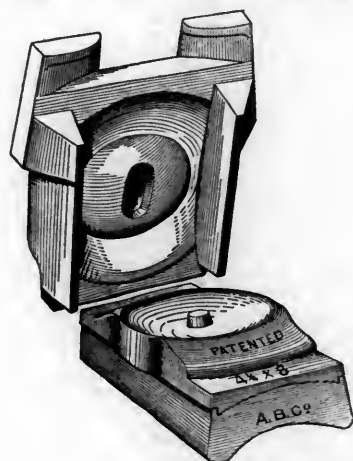


Fig. 2.

carried uniformly to the journal. A projection at the center of the brass passes into an elongated hole in the wedge and prevents excessive side motion due to emergency thrusts. The spherical surfaces bear such a relation to each other as to cause the weight of the car to be raised by side thrusts, causing a tendency to restore the bearings to their normal condition again afterward. Such thrusts are resisted and cushioned by the action of the wedge and the box.

A section through the brass is shown in Fig. 3. It is also ingenious and is made in three parts; 3 is the anti-friction bearing metal lining; 2 is the bronze backing for the soft metal, and 1 is a cast steel back, which is strong and stiff and is fused or welded to the bronze part. In earlier forms the bronze part was riveted to the cast steel back, but even moderate heating of a bearing made the rivets brittle and the fusing was devised to overcome that difficulty. The union of the metals

when seen in a section of a brass is close and apparently very strong. The cast steel back not only strengthens the structure, making it stiffer than if of solid brass, and therefore less likely to break transversely, but it also reduces the cost.

The brass and wedge when used together will fit the M. C. B. box and the wedge of this adjustable bearing may be used with an M. C. B. brass in the M. C. B. box, so that this bearing will give no trouble on the road whenever a new brass may be required, if an M. C. B. brass is at hand. Experience with these bearings appears to support the claims made for them, and the first cost ought to be much less than that of the ordinary brass. The lubrication of journals ought to be improved by distributing the load uniformly, and it is fair to expect a reduction of train resistance from the smaller amount of friction. It is most important that no change in the boxes is required for these bearings, and also that there is no increase in the number of parts. It is seldom that such a simple device receives the careful study given to this bearing. Some of these bearings have been in constant use in passenger service since November of last

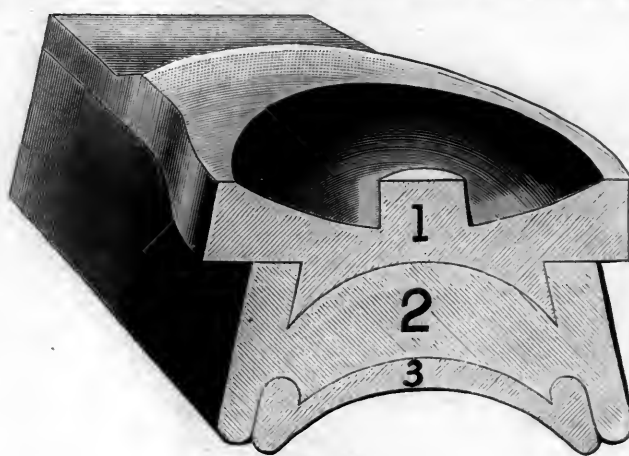


Fig. 3.

year and are reported to be in excellent condition. Other bearings made on this plan, but with riveted cast steel backs, have been in constant service since July, 1897.

PIECEWORK ON THE INTERCOLONIAL RAILWAY IN CANADA.

Establishing piecework and assigning prices is a delicate matter, because of very well understood reasons, and it is particularly difficult to introduce such a system in an establishment which has a large proportion of old employees. Such a situation is seen at the Moncton shops of the Intercolonial Ry. of Canada, and the exceedingly fair method adopted by Mr. G. R. Joughins, Mechanical Superintendent, to place piecework before the foremen is commendable. His circular was printed in the "Railway and Shipping World," as follows:

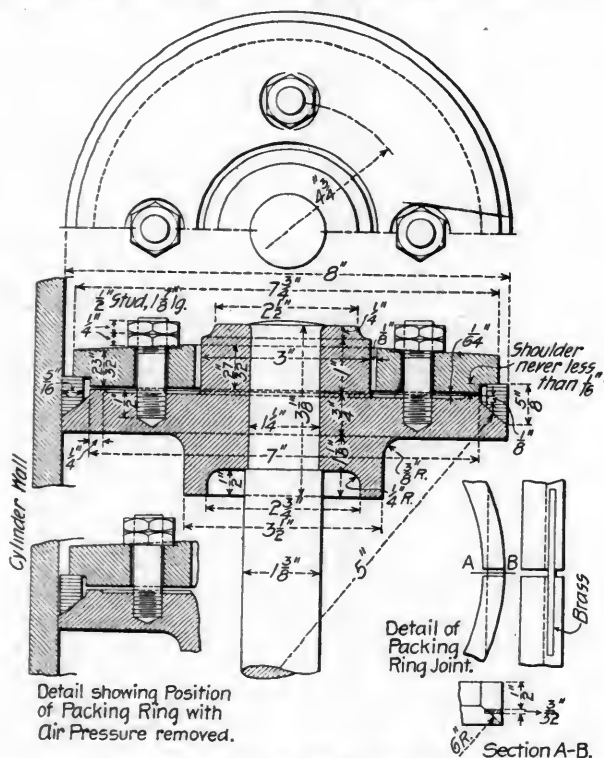
"The management of the Intercolonial wish you to assure all those who will adopt the piecework system, that their desire is to have the work so done and prices so made as to be of mutual advantage, that it be more of a profit sharing than a piecework system, believing that the men have an interest in the prosperity of the road and of the town in which they live. With this end in view each man on piece work will have the full benefit for six months of all improved methods he may use to turn out work, no matter how much wages he may earn within reason.

"On January 1 and July 1 each year prices will be revised to a usual fair and just basis between the men and the railway by mutual agreement. The expectation and object of the management is to see every able-bodied man in its employ busy, prosperous and contented, doing a fair day's work for a fair day's pay or wages. This is not piece work on the ordinary plan, but on a co-operative mutual benefit plan. There will be no unfair crowding to get a lot of work done at cheapest possible rate. No one will be compelled to accept piece work, and

any one may drop it whenever he sees fit to do so, while those who are old and feeble will not be expected to undertake it. There may, of course, be exceptions to the above where there appears to be any glaring mistake. The prices will then be raised on behalf of the workmen, or lowered on behalf of the railway, or cancelled, as may be necessary; the idea being to share the profits of any improved method which may be introduced by the foremen or the men, so as to make it really an industrial partnership."

RAMSDELL'S AIR BRAKE PISTON PACKING.

This packing, designed and patented by Mr. F. H. Ramsdell, has been given a thorough test on the Boston & Maine Railroad with satisfactory results. The construction is clearly shown in the drawing. It consists of a split packing ring having a concave conical or spherical surface, fitting a corresponding surface on the piston head, and the joint in the ring is made tight by a brass connecting piece. The follower plate rests on the upper flat surface of the ring, but does not touch



Ramsdell's Air Brake Piston Packing.

the piston head. The follower plate is in the form of a ring fitting loosely over the hub of the piston head, the opening in the ring being larger than the hub, so that these two parts do not touch.

This arrangement permits the packing ring to be forced out against the walls of the cylinder by the air pressure, the spherical surface acting to open the ring and make an air tight joint with the cylinder. When the pressure is released the ring springs back, as indicated by its position in the engraving, and for this reason there is no friction between the packing and the cylinder during the return stroke. This reduces the wear and eliminates the resistance of the packing in restoring the apparatus to its normal released position. The packing is adapted to all air brake cylinders without necessitating changes in construction, and the old pistons may be used. The function of the ball or spherical joint is to provide automatic adjustment of the packing to take care of wobbling of the piston rod. It is stated that in one case a movement of the rod of 3/4 inch each way from the center, or a total movement of 3/4 inch, gave no trouble in the packing and caused no leaking.

The annoyance occasioned by the wear of leather packing is well understood, and a comparison of the durability of this

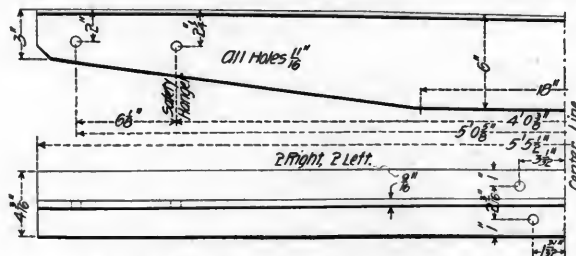
and leather packing is very favorable to the metallic. Ramsdell's packing has been in constant use in both horizontal and vertical cylinders since October, 1897, and the cylinders and the packing are reported to be in better condition than when first applied, the cylinders are polished and the packing is tight.

In one of these cases the packing was applied to a passenger locomotive in local service and had made 11,584 miles at the time of the test. In two cases the engineer made two reductions of 10 pounds each, the speed being 60 miles per hour. The first was made at a considerable distance from the station and the second near the station. The equalizing pressure was 50 pounds, which is exactly what it should be under these conditions, showing that there was no appreciable leakage. July 1, 1899, the packings were examined again and no wear of the rings was found. As this was a case of local service, with frequent stops, the results are sufficient to demonstrate the practicability of the packing. From the experience on the Boston & Maine this packing is considered as specially valuable when applied to driver brake cylinders which are located near the firebox on account of the heat, which injures the ordinary leather packing in such a location. The road will, however, give it a longer trial before adopting it as a standard for all locomotives. Six locomotives are now equipped with it.

SOUTHERN PACIFIC STEEL BRAKE BEAM.

A steel brake beam made from scrap steel rail has been in use on the Southern Pacific for some time, and we illustrate it by courtesy of Mr. H. J. Small, who kindly furnished a drawing, together with some facts bearing on its manufacture, as follows:

"The old rails are cut to length, heated in a furnace, and the head of the rail is then hammered down to the form as shown in the engraving. A force of five men, consisting of a heater,



Brake Beam Made of Old Steel Rails.
Southern Pacific Ry.

one fireman at the furnace, one hammer man and two men handling the beam under the hammer, produce seven beams per hour. The beams are then taken to the shears and cut to shape, our shear knife being sufficiently long to make the taper cut at each end at one revolution of the shears. We have found this a cheaper process of manufacture than rolling them, from the fact that they require considerable manipulation after leaving the rolls, in the way of straightening out kinks, etc."

A little calculation will show these beams to be made at a very low labor cost, and, since the material is scrap, it is seen that a good, serviceable brake beam is obtained very cheaply.

Aluminum feeders will be used for the Northwestern Elevated Railroad in Chicago. The order recently placed with the Pittsburgh Reduction Co. calls for 150,000 pounds of that metal, which will be delivered in cables of three sizes, of which the largest will be about 1 1/2 inches in diameter and 10 miles in length. The second size will be 10 miles long and the remainder is smaller in diameter. The cost of the aluminum is about 36 cents per pound, and as about 47 pounds of aluminum is equivalent in conductivity to 100 pounds of copper, which costs 20 cents per pound, the use of aluminum is advantageous.

shows itself much more prominently than any difference in mere wages. Any change in the distribution or rate of wages is also cleverly shown, this being something which is too easily overlooked with ordinary methods, when there is no change in the total of a certain pay roll." Mr. Lyon uses charts for nearly all locomotive and car records, and finds it worth while to go to the expense of a little extra clerical force in order to put the records in such easily understood form. The inference to be drawn is that he can keep so much better informed of the conduct of his department as to pay for the additional clerical work necessary to draw off the records in this way. It would appear that he needs no argument to prove this to be true.

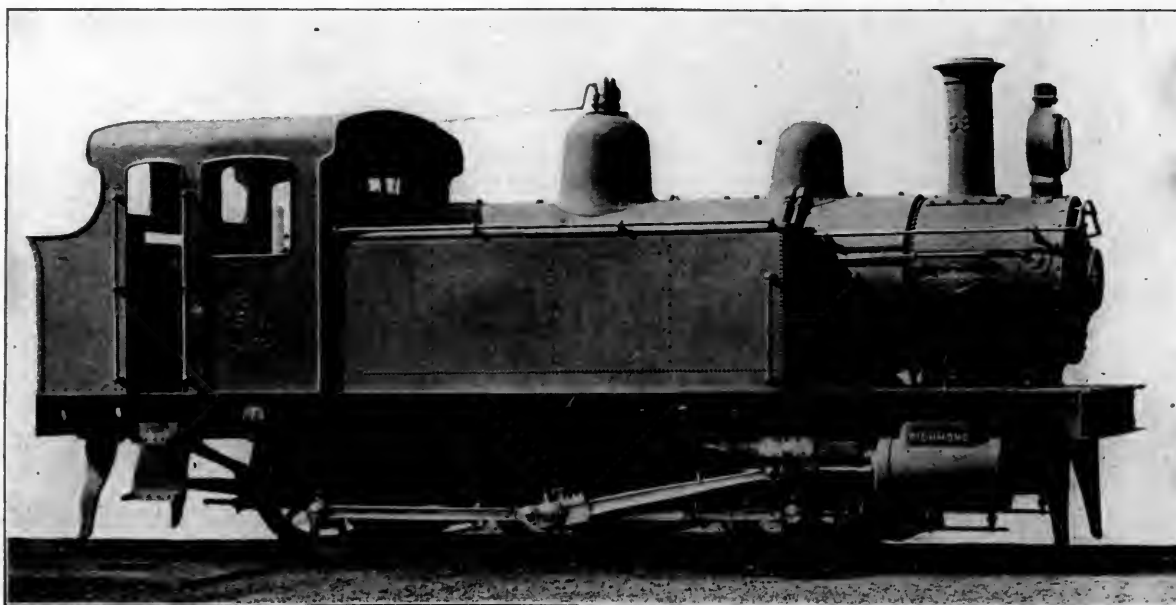
RICHMOND LOCOMOTIVES FOR SWEDEN.

Six-Coupled, Side Tank Locomotives.

The Richmond Locomotive Works have delivered 10 six-wheel connected, side tank locomotives to the Swedish State Railways, a photograph and the dimensions of which have been received from the builders. The locomotives are interesting chiefly because they are to be used north of the Arctic

American locomotives. The cab arrangements, like those of the six-wheel connected tank locomotives, are made for the runner to sit on the left hand side of the cab. These engines are to be used in fast passenger service in the southern part of Sweden.

These locomotives, which are much larger than those already described, are also built for standard gauge and for burning coal. The total weight is 122,000 pounds, 87,000 pounds being on the driving wheels. The driving wheels are 62 inches in diameter and the driving wheel base is 12 feet 8 inches. The Richmond system of compounding is used, with cylinders 20 and 31 by 24 inches. The valves are of the Richardson balanced type, with an auxiliary port in the low-pressure valve, after the design described elsewhere in this issue. The driving axle journals are $7\frac{1}{2}$ by $9\frac{1}{2}$ inches. The front end of the engine is carried by a four-wheel swiveling truck, with McKee-Fuller steel tired wheels. The truck axles are of steel, with $5\frac{1}{2}$ by 10-inch journals. The boiler has an extended wagon top with radial stays and the working pressure is 180 pounds. The outside diameter of the first course is 57 inches. The grate area is 19 square feet, the grate being 80 by 34 inches, and the firebox is 65 inches deep in front and 54 inches at the



Six-Coupled Side Tank Locomotive—Swedish State Railways.
Built by THE RICHMOND LOCOMOTIVE WORKS.

Circle. They are built to standard gauge and weigh 75,000 pounds on a wheel base of 12 feet. The cylinders are 15 by 22 inches, and are fitted with Richardson balanced valves. The driving wheels are 48 inches in diameter. The diameter of the boiler is 47 inches and the working pressure is 165 pounds. The firebox is 55 inches long by 34 inches wide, and its depth is 59 inches in front and 50 inches at the back. The grate area is 13 square feet and the total heating surface 868 square feet. The tubes are 2 inches in diameter, 10 feet 6 inches long, and the number is 146. The water tank capacity is 1,000 gallons, and the coal capacity $1\frac{1}{2}$ tons. The boiler is fed by two No. 7 "Monitor" injectors. The firebox and water space stay bolts are copper, the other stays being of "Brown" iron. The engines have screw couplings, snow plows, hand brakes and Keasbey & Mattison magnesia sectional boiler covering. With few exceptions the details of these engines are in accordance with American practice, but they are much smaller than modern American locomotives. In these engines the runner sits on the left hand side.

Compound Ten-Wheel Locomotives.

The same builders have also delivered 10 ten-wheel compounds to the Swedish State Railways, which, with the exception of the absence of bells and pilots, and the use of six wheels instead of eight under the tender, strongly resemble

back; the firebox material is copper and the water space stays are also copper, while the other stays are of iron. The tubes, 229 in number, are of iron, 2 inches in diameter and 12 feet long. The heating surface is 1,650 square feet. The weight of the tender empty is 34,000 pounds. It will carry 3,300 gallons of water and 7 tons of coal. We are indebted to the Richmond Locomotive Works for the photograph and information. These compound locomotives are so nearly like those in use here as to constitute an acceptance of American practice in Sweden.

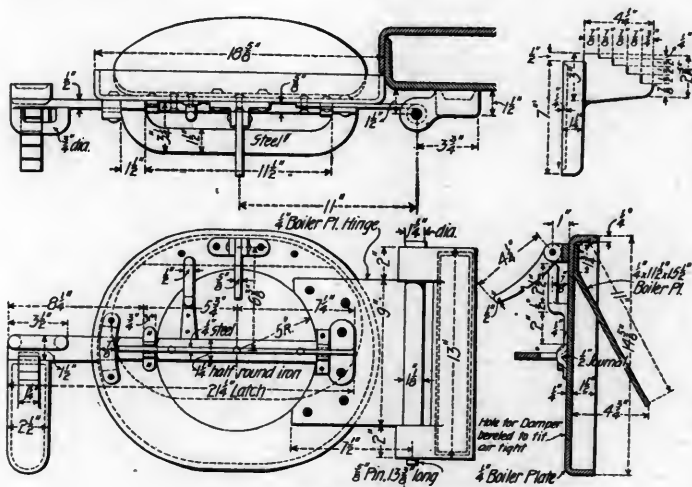
"The Laboratory; Its Relations to a Railroad," was the subject of a brief paper recently read by Mr. J. A. Carney, of the "Burlington," before the St. Louis Railway Club. The author commented upon the peculiar moral influence of a railroad laboratory upon the manufacturer, saying that no implication is made that the manufacturer is dishonest, but he is a little more particular about his product if he knows that it is to be submitted to a careful laboratory inspection. Some years ago it was reported that the laboratory of a certain railroad had been closed. The report was without foundation, but, nevertheless, the manufacturers were under the impression that it was true, and they were not so particular about their products as they had previously been, and as a result more material of all sorts was condemned in a few months than in any two years since the laboratory had been in existence.

PRESSED STEEL FIRE DOOR FOR LOCOMOTIVES.

New York Central.

In describing the new locomotive built by the Schenectady Locomotive Works for the Chicago & Northwestern Ry., on page 188 of our July issue, the fact was noted that the fire doors were made of pressed steel, and that by the use of this material a saving of about 200 pounds in weight was effected. On looking up the design it was found to have been originated by Mr. William Buchanan, formerly Superintendent of Motive Power of the New York Central, from whom we received the drawing before his retirement. The design is in use on that road and an examination of the engraving shows it to be very neat and worthy of attention.

The door itself is 18 $\frac{1}{2}$ by 14 $\frac{1}{2}$ inches in outside dimensions, the form being that of two semi-circles connected with straight lines. The door is pressed into shape from $\frac{1}{4}$ -inch boiler plate, with a flange 1 $\frac{1}{2}$ inches deep and is carried by a



Pressed Steel Fire Door.
New York Central Railroad.

broad hinge also made of plate of the same thickness and riveted to the door by four $\frac{1}{2}$ -inch rivets. The stationary part of the hinge is a casting. At the center of the door a circular hole 10 inches in diameter is cut for a circular damper, the edges of the hole being beveled to fit the damper with an air-tight joint. The damper is hung on horizontal trunnions and a latch at the top permits of fastening it open at the required point for the desired amount of air admission. An internal deflector tends to protect the door from the fire and to direct the incoming air downward toward the fire. The latch bar is of steel and extends across the door. Aside from the saving in weight from the use of pressed steel, the door is noteworthy on account of the very satisfactory regulation of the air admission. The saving in weight may be considered too small to be important, but the fast mail engines referred to embody a number of features in each of which a little weight was saved and the aggregate saving was by no means insignificant. The fact that the heating surface was 2,514 square feet and the weight on driving wheels only 85,700 pounds, shows the extent to which the weight saving was carried. The importance of this, when it makes it possible to put the weight into the boiler, is obvious.

THE STEREOPTICON IN THE EDUCATION OF EMPLOYEES.

The stereopticon as a necessity in the better education and more intelligent training of railroad employees was the subject of a paper read recently before the Central Association of Railroad Officers by Mr. W. J. Murphy, Superintendent of the C. N. O. & T. P. Ry. Mr. Murphy has been very successful in the use

of the stereopticon in instructing men and examining them as to their knowledge of their duties, especially in regard to signals. He was led to seek this method because of the difficulties which he had experienced in putting a certain interlocking plant into operation. The situation was complicated by combining the entrance to a busy freight yard; a single track bridge, with interlocking signals; the train staff governing the use of the bridge, and to make matters worse, the usual and correct locations for some of the signals could not be used owing to obstructions, which would prevent them from being seen from a sufficient distance. The rules were carefully illustrated by engravings and were as carefully explained to the men two weeks prior to the date of putting the plant into service. After taking these precautions much damage was done through misunderstanding the indications of the signals, and it was found necessary to assemble the men on the ground and go over the entire plant with them, after which there was no trouble.

Mr. Murphy finds his system advantageous in that the lantern slides virtually bring the men before the actual conditions at such points without going out on the road, and it is possible, by questioning them, to ascertain that they not only understand the signals, but that they see the relation between the signals and the conditions which they govern. The rules in regard to signals may to a certain extent be explained by aid of models, but it is obvious that the particular conditions surrounding signals as they are applied at complicated interlocking plants can not be shown or explained by the general instruction which may be given by means of models. Mr. Murphy explains the advantages of his method in these words:

By the aid of the stereopticon any existing conditions can be brought into the examining room, not only the signals, but the tracks, the signal towers, the bridge, the bridge signals, the ground itself, so that the employees can see the situation in the examining room as it actually is on the ground, and the examiner is soon able to determine whether the candidates who are being examined fully comprehend the situation.

In the education of trainmen the object desired is not only that they should have a thorough knowledge and uniform understanding of the signals in their various positions, but they should also be taught the relations which a particular signal or appliance has to something else; in other words, they must know definitely the relations existing between a signal and its intimate surroundings. For instance, in the case of a home signal with several arms, one or two of which may indicate proceed: It is not only necessary to know the position indicating proceed, but it is also necessary, in order to proceed as indicated by the signal, to know absolutely the particular track governed by the vertical arm.

The use of the stereopticon develops the knowledge or the lack of knowledge of the employees, not only as to signals, but also as to their proficiency in the train rules generally.

It is, perhaps, well to explain that when an employee is being examined by this method he, and not the examiner, does the necessary explaining. It is his duty to explain what the signals are, where they are, what they govern, what the different positions indicate and what the rules require under the different conditions in the different positions, etc. In this way there can be no question as to the thoroughness of the examination, nor as to the knowledge and understanding of the party undergoing the examination.

Railroad operation is one of the most progressive sciences of the day. The successful operation of a railroad, however, is entirely dependent upon a thorough education of the employees in all the necessary requirements of the rules laid down for their guidance, thereby enabling them to intelligently and successfully apply them in practice.

The Baltimore & Ohio Southwestern is pushing forward its improvements between Parkersburg and East St. Louis; 17,000 tons of 85-lb. rail have already been laid and 25,000 tons remain to be put down, delivery now being slow from the mills. Gravel ballast has been put in on 125 miles, and 200 miles more are to be done this season. The improvements include many grade reductions, and the line is being straightened in several places between Cincinnati and St. Louis. The plan is to reduce the grades between these two points to one-half of one per cent. The work on curves will shorten the line one and one-half miles, 360 degrees of curvature being eliminated. Seven bridges are to be abandoned by filling with earth.

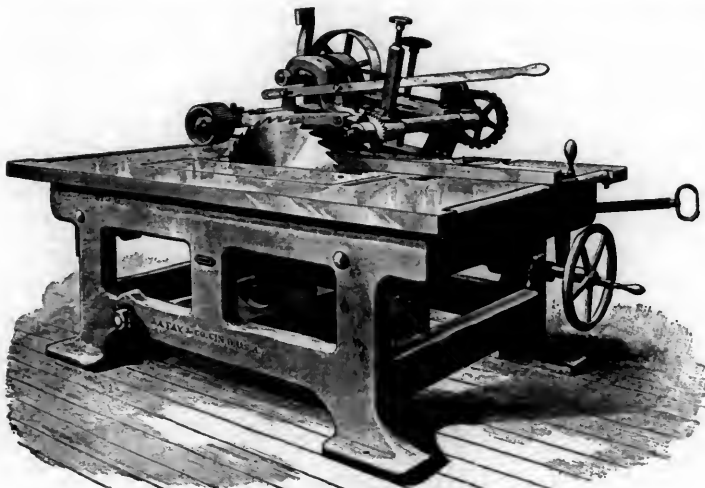
A LARGE SELF-FEEDING RIPPING SAW TABLE.

The machine illustrated by the accompanying engraving is a large, strong and durable ripping saw table with automatic feed, designed with special reference to the requirements of car builders and others who need strong and rapid working machines of this character.

The feed consists of a combination of gearing chain and belts operating a toothed feeding disk, acting on the top surface of the lumber in the same line in which the saw cuts, and a power-driven, fluted delivery roll for carrying the product clear of the saw. It is under perfect control by the hand lever, and can be quickly started or stopped instantly.

The feeding disk and delivery roll may be retained at any desired height from the table by means of hand wheels and screws, and the entire feeding mechanism may be elevated and thrown back out of the way or sustained by a supporting rod, if it is desired to do ordinary ripping. Three speeds of feed—viz.: 47, 84 and 130 feet per minute—are furnished.

The mandrel is of steel, 1½ in. in diameter where the saw is applied, and is arranged so that several saws may be used at a time, and by using several feeding disks on the feed shaft, the



Large Ripping Saw Table.
J. A. Fay & Co.

machines will be brought to their full capacity. A long outside bearing supports the driving pulley. Each machine is provided with an improved adjustable fence, which may be instantly fixed at any point.

The table is 78x46 in., made of iron, and has a hand wheel and a raising screw at the front end for raising it in parallel planes. Friction rolls are placed in the table, just below the feeding disk, and a roll to relieve the material from friction. A saw 36 in. in diameter may be used, which will rip material up to 14 in. thick and 21 in. wide.

This machine is the latest product of J. A. Fay & Co., Nos. 516 to 536 W. Front St., Cincinnati, Ohio, and is known as their No. 3, large, self-feeding, ripping sawtable.

REAMED HOLES FOR LOCOMOTIVE BOILER RIVETS.

It is impossible to take too great care in the details of locomotive boiler construction, in view of the high steam pressures that are now used. The best practice is to ream or drill rivet holes throughout the boiler, and while this is not new, it is well to be reminded of the reasons. Mr. T. R. Browne directed attention to the necessity for smooth rivet holes in his recent remarks before the New York Railroad Club in discussing the subject of locomotive boiler construction. He said:

"It is a mistake to depend on the rough condition of the average punched hole as a finished product for the inserting of rivets. Every hole in the boiler should be reamed, allowing at least ¼ inch on a side for reaming out; or, in other

words, the rivet holes should be punched ¼ inch smaller than their finished size when the rivet is inserted. Bolts should be inserted in every other hole, thoroughly clamping the sheets together and the intermediate holes reamed, and the bolts inserted in the other holes. They should then be taken out and placed in these, the reaming completed, and the last set of bolts left in until the rivets have been driven in the last holes reamed. In connection with the objection to punched holes, we would call attention to just one point which we think will be sufficient, if no other points are brought out to condemn the punched hole. It is a well recognized fact that these holes not only are tapered, but are more or less ragged and irregular on their inside edges. The shanks of iron rivets driven into holes of this kind, will be found to follow the exact contour of the holes, and the fiber of the iron will be found to have a direction which is anything but a straight line. Any tendency to strain the rivet in the direction of its length must, of necessity, first straighten out these fibers before the rivet is in position to resist its maximum stress; in other words, as long as the fiber of this rivet does not follow a straight line, it has not reached its point of maximum resistance before breaking. This is not the case in a straight or reamed hole, for obvious reasons."

A NEW REVERSIBLE PNEUMATIC BORING MACHINE.

An improved light weight and easy running reversible boring machine has just been brought out by the Chicago Pneumatic Tool Co., the appearance of which is shown in the accompanying engraving. This machine will be known as the Whitelaw No. 5 Reversible Wood Boring Machine. It is very compact, convenient for handling and much lighter than the other



No. 5 Whitelaw Boring Machine.
Chicago Pneumatic Tool Co.

Whitelaw tools. It weighs less than ten pounds and yet has sufficient power for boring holes up to three inches in diameter in wood. The machine is provided with ball-bearing throughout, including the crank and piston connections. These bearings are used to reduce the friction of the machine and also to reduce the frequency of lubrication. The machine is reversed

by giving the handle a quarter turn, and it may be reversed while running at full speed. We are informed that it operates equally well when running backward or forward. It is considered a marked improvement over previous tools of this type, and it is understood that those using pneumatic tools, who desire to put this one to a test will be provided with one of them for the purpose upon application to the manufacturers.

Three regular trains running 194 miles without a stop are now scheduled on the Great Western Railway, England, between Paddington Station, London, and Exeter. The fastest of these, according to Mr. Chas. Rous-Marten, in "The Engineer," is timed at 56 miles per hour. The same road runs two express trains from London to Birmingham, 129½ miles, without a stop, and one of them runs at 53½ miles per hour for the trip. Also a train to South Wales is very fast, running from Paddington to Bath, 106 miles, without a stop, at the rate of 54.3 miles per hour.

BOOKS AND PAMPHLETS.

Marine Boilers: Their Construction and Working; Dealing More Especially with Tubulous Boilers. By L. E. Burtin, Chief Constructor of the French Navy. Translated and Edited by Leslie S. Robertson. With a preface by Sir William White, Director of Naval Construction to the British Admiralty and Assistant Controller of the Navy. 437 pages, 250 illustrations. New York: D. Van Nostrand Co., 23 Murray Street, 1898. Price \$7.50.

This is a book which every engineer having to do with steam boilers should own.

The author is in responsible charge of the design of the latest French naval vessels and is the best authority on French naval practice, both in naval architecture and marine engineering. Responsibility for these two branches of marine construction is not divided in France, and this book is therefore written with the benefit of the knowledge possessed by both marine engineers and architects. The latter will find important discussions of value in the preparation of designs with regard to properly providing for the steam plant. In the French Navy the water tube boiler has had more attention than it has received anywhere else, and the author treats of the experience very frankly, fairly and exhaustively. The types of boilers are treated individually and the merits and faults of each are plainly stated. The history of each type, its experience and the probable line of future improvement are traced. Sir William White, in his introduction, says that this book presents the best summary yet available, from a French source, of the experience with water tube boilers.

The book had its origin in lectures on Boiler Construction by the author to the future engineers of the French Navy at the "Ecole du Génie Maritime." It was prepared for a special audience and was written because of the lack of a book on the evolution that was going on in boiler construction. The author is not an inventor and is therefore better able to form impartial judgments on the various systems described. The translator has admirably done his part of the work, and the author says that the translation, editing and elaboration of the English edition occupied more time than the original French composition. The editor in his preface comments upon the great amount of attention given to the important question of coal consumption by the French and commends the results of trials recorded in the book to officers of other navies. The translator is to be credited with the index, which is unusually complete and convenient and adds greatly to the value of the book as a reference work. The general divisions of the book are as follows:

The Principal Laws Underlying Steam Navigation; Notation Employed; Short Description of Various Types of Boilers; Brief Description of Marine Engines; Production of Heat from Coal; Liquid Fuel for Marine Boilers; Production of Heat; Tubular Boilers; Locomotive Boilers; General Remarks; Tubulous Boilers; Boilers with Limited Circulation or Coil Boilers; Boilers with Free Circulation; Boilers with Accelerated Circulation; Advantages and Disadvantages of Tubulous Boilers; Comparison of the Different Types; Weight and Space Occupied by the Tubulous Boilers; Boiler Mountings and Other Fittings; Boiler Steam Fittings; Feed Accessories; Accessories Relating to the Disposal of Ashes.

Mr. Burtin has given a large amount of information that has never before been published and has not been available to more than a very few who have enjoyed exceptional opportunities. There is very little of the text book about it, although considerable attention is given to certain of the details of construction. The author's object evidently was to cover principles, but he has not neglected necessary references to the details of construction. The strength of the book lies in the records of the experience of the French Navy in the use of nearly all of the modern types of boilers. These records are freely and frankly expressed in such a way as to inspire confidence that they are the unbiased judgment of one who knows what he is talking about. Some of this information is of the kind that has heretofore been religiously suppressed and held by the manufacturers of the boilers. Various boilers are compared with reference to their ability to make steam, the trouble of maintaining them and their life of service. They are considered under the conditions of long voyages made under the exigencies of naval service.

Water tube boilers are divided into three classes: Those with limited circulation, those with free circulation, and what the author terms accelerated circulation. The Belleville boiler is typical of the first class because of the slight incline of the tubes. The second type is represented by the Babcock & Wilcox, the D'Allest, the Penelle and the Joessel boilers. The Oriolle boiler is mentioned as having been quite successful with coke and other short flaming fuels because of the short distance between the grates and the heating surfaces. The third type is represented by the Yarrow, the Thornycroft and the Mosher boilers. In these the circulation is more rapid than the motion of the steam bubbles through the water. The author has gone into great detail in discussing the advantages and the disadvantages of the different types and he gives a large amount of information the usefulness of which is not by any means confined to marine practice. M. Burtin seems to incline to the opinion that the importance of rapid circulation has been overestimated. He states one of the advantages of the Belleville boiler to be due to the character of its circulation, and this is contrary to the generally accepted opinion.

It must not be thought that the water tube type only is considered. This type is given an amount of attention commensurate with its importance in French practice, and as the French Navy has experimented very extensively in this direction the book owes its chief value to its treatment of this type. The closing chapters are chiefly devoted to the accessories and to the weights and space occupied by the various boilers. The prices paid by the French Government for boilers are stated, and this may be taken as an example of the frankness of the author throughout the work. He does not fail to call attention to the fact that the water tube boiler has serious disadvantages in the relatively small water space and the necessity for the use of pure feed water. The small amount of water that they will hold renders it necessary to watch the feed arrangements with great care. Quite a little space is given to M. Henry's tests on locomotive boiler tubes on the Paris, Lyons & Mediterranean Ry., and such subjects as the advantages to be derived from feed water heaters are discussed. Distillers and ash ejectors are described.

The book is well printed except as to the engravings. These are not good, and they mar a book which is in every other way admirable. M. Burtin has given us an important historical record combined with a very valuable series of comparisons based on a wide experience, and he incidentally offers many suggestions that are worthy of study by those who have to do with entirely different kinds of boilers from those which he treats.

Engine Room Practice. A Handbook for Young Marine Engineers. Treating of the Management of the Main and Auxiliary Engines on Board Ship. By John G. Liversidge, Chief Engineer R. N., London, Charles Griffin & Co., Philadelphia. J. B. Lippincott Co. Cloth, 8 vo. pp. 292. Illustrated. Price, \$2.50.

This work is a thoroughly up to date handbook on the prevailing type of vertical marine engine and its accessories in naval and mercantile service. The first impression obtained from it is the great importance of auxiliary machinery in a modern steamship of whatever type, a large portion of the attention of the author having been given to this part of the engineer's duties. The author treats of the discipline, duties and organization of the engineer's force in both naval and merchant service. He goes carefully into the details of the

work in the engine-room in preparing for the voyage, in preparing to get up steam and starting the engines, running them and the boilers and in conducting the voyage. The working of the complex steam plant of a steamship is seen to be extremely complicated and the insight given to the uninitiated into the every-day difficulties of the engine room is a convincing argument for those who have urged the proper recognition of the engineer's force in our navy. A very important part of the work is that which treats of emergency and port repairs to the engines, boilers and auxiliaries. Good use is made of sketches in presenting this subject. The difficulties of keeping steam pipes in order seem to be very great. The chapters on pumps, electric and hydraulic machinery, feed water heaters, evaporators and refrigerating machines present a great deal of information. There are also other parts of the equipment of ships, such as bulkhead doors, valves, piping systems and various fittings which are used by others and maintained by the engine room force. The author also treats the subjects of placing ships in dry docks and duties in harbors, and gives a chapter to Bellville water tube boilers such as are in use by the British Navy. The book is written in clear, concise language. It is well printed with the exception of most of the engravings, and marine engineers and those engaged in building and installing marine machinery will find it valuable and suggestive. It is the only good modern book on this subject that we have seen.

A Primer of the Calculus. By E. Sherman Gould, Member Am. Soc. C. E. Second Edition. D. Van Nostrand Co., 23 Murray St., New York. 1899. Price, 50 cents.

The rapid sale of the first edition of this little book in the Van Nostrand Science Series compelled the revision of the work and it appears on the same lines of the earlier edition, but considerably enlarged. The book gives a development of the infinitesimal calculus as far as the first differentials of algebraic functions of one independent variable and their corresponding integrals. In other words it is confined to the rudiments of the science. The treatment is complete as far as it goes, and no pretension is made for covering the subject completely, the student being left with a clear view of the broadness of the subject. The author states in the preface his opinion that it is better to communicate a working knowledge of the science by teaching a few elementary rules and after this put them into immediate use as far as they will go, rather than to attempt the presentation in any other way. This plan is followed and the remarks concerning the logical basis of the science are reserved for the final chapter. The process is taught first and the reasons why come afterward. This is done to avoid confusing the student with the parts of the theory which are often somewhat perplexing. The student is expected "to pick up a good deal of the doctrine as he goes along." For exhaustive treatment other works are recommended. The chapters are: Differential Calculus, Integral Calculus, Applications of Differential Calculus, Maximum and Minimum Application of Integral Calculus, Applications of Both Combined, Miscellaneous Applications, Limitations, and Additional Examples. A student having a clear idea of the lower mathematics may obtain a working use of the calculus by aid of this carefully written little book, which is specially commended because of the attention which is paid to the practical applications of the science. The presentation is not obscured by the use of the methods of limits. We recommend the work to those who desire an elementary treatise on the subject.

"Snow on the Headlight." A Story of the Great Burlington Strike. By Cy Warman. 12 mo., cloth. D. Appleton & Co., New York. Price, \$1.25.

This book is intended to give an interior view of a strike, the locomotive engineers' strike on the "Burlington" in 1888, which was one of the most notable industrial struggles involving a railroad and a labor union. It lasted a year and this book gives a fair and unprejudiced account of much that made it memorable. Every railroad officer and every employee of whatever grade would be less likely to contribute to bringing about a strike if he would read and ponder these chapters. The author shows the real cause of the trouble and presents a view of both sides. In the narrative the sufferings and the terrors of strikes in the homes of the strikers are unmasked and an occasional hot shot is fired at the methods of "The Company." The chief moral is the uselessness of the strike as an institution, and if men preparing to "go out" could be induced to read it they will stop to think before committing themselves.

We approve the author's purpose, but those who knew and understood the officers who conducted it, and particularly the one who was in responsible charge, cannot help feeling that the author is taking liberties in that he does not give a history but merely a story founded on a few of the items of the history. It would take several volumes to present a complete account, and that was not the author's intention. The book presents a side of that interesting character, the railroad man, which it is not given to the general public to see, and it will be read with interest by many who have nothing to do with the operation of railroads. The preface is unique and noteworthy. It is as follows: "Here is a decoy duck stuffed with oysters. The duck is mere fiction. The oysters are facts. If you find the duck wholesome, and the oysters hurt you, it is probably because you had a hand in making this bit of history, and in the creation of these facts."

Patents and How to Make Money Out of Them. By W. B. Hutchinson and J. A. E. Criswell, members of the New York Bar. Small octavo, 232 pages, with index. New York: D. Van Nostrand Co., 1899. Price \$1.25.

The objects of the authors of this book were to assist those seeking patent protection in using their energies in profitable directions and to enable them to avoid falling into the hands of unscrupulous and incompetent attorneys; in other words, to tell you how to make money out of inventions.

It is elementary in character and treats of the nature and history of patents, as well as the points of patent law which it is necessary for patentees and the purchasers of patents to know. Trade-marks, caveats, copyrights and labels are also included.

In telling the reader what should be patented, this book will be valuable, and the reviewer might have saved the cost of several patents some years ago, if he had the advantage of the sensible suggestions of the authors on "What to Invent." The sale of patents and the function of the promoter are treated. It is specially urged that the first step in taking out a patent should be a thorough investigation in regard to the "state of the art." Many patents are applied for without the least attempt to discover whether the subject is patentable or not. The next step is to consider the probable demand. The book is strongly recommended to coupler inventors and the class who rush blindly into expenses for patents without stopping to think of the most important questions involved. The methods for procedure after deciding these questions are given briefly and clearly.

Western Railway Club. Official Proceedings for the Club Year of 1898-9. Published by the Western Railway Club, Chicago. Pages, 416; standard size (6 by 9 inches). 1899.

Next to the proceedings of the Master Car Builders and the Master Mechanics' Associations, those of the Western Railway Club are the most valuable of the records of the deliberations of motive power organizations, and the appearance of the annual volumes bound in permanent form, which is uniform with those of the other associations mentioned, is heartily commended. The record of the past year's work is worth preservation, and the work is well done and beyond reasonable criticism, with the exception of a mild suggestion in connection with the index at the end of the volume. It is the intention of the club to present members with these volumes at the close of each club year, and people will generally agree with us that this is better than to put the money into banquets. The other clubs will find this idea worthy of consideration. In future volumes it is to be hoped that the subjects discussed will be arranged more conveniently in the index. For example, the paper by Mr. G. W. Scott entitled "Heating Large Railroad Stations and Shops," is indexed under Scott and under Heating, but not under Shops. Handling Sand for Locomotives does not appear under Sand. More thorough cross indexing would improve it. The indexing of the names of speakers is exceedingly complete. The work throughout is creditable to the club and to Secretary Whyte.

Roper's Engineers' Handy Book for Steam Engineers and Machinists. Revised and enlarged by E. R. Keller and C. W. Pike. Fifteenth edition. Published by David McKay, 1022 Market St., Philadelphia. 1899. Price, \$3.50.

This edition of "Roper" is revised so thoroughly that it might as well have a new name. It contains a vast amount of information which will be valuable especially for those in charge of steam plants and other machinery, including electric generators and motors. The editors have included material which in most cases may be found elsewhere, but in this collection it is well adapted for the men who will consult it most frequently.

The consideration of materials and their strength and the transmission of power is quite elaborate for a work of this kind and the portion devoted to electricity covers 120 pages. It is a compact and sensible treatment of the principles of the use of electricity, the measurements of current, electric generators, motors, accumulators and the telephone. This portion of the book was written by Mr. Clayton W. Pike, ex-President of the Electrical Section of the Franklin Institute. In addition to the electrical section the book contains a new chapter on gas and gasoline engines. We desire to commend the use of large type and also the appearance of the book generally.

Proceedings of the Railway Signaling Club; 1897-1898. Published by the Club. Edited by the Secretary, C. O. Tilton, C., M. & St. P. Ry., West Milwaukee, Wis. Paper; 8 vo.; 130 pages.

The proceedings and papers with their discussions for the past two years have been published in pamphlet form. The earlier proceedings which have been published in the railroad papers are not included. The volume before us includes the constitution, list of members and rules recommended by the club for the operation and maintenance of interlocking plants. This is probably the most important work of the club, as it embodies the opinions of the men who are in position to know the requirements of operation and maintenance. Among the papers the following are the most important: "The Derail as a Moral and Physical Agent in Safe Railway Travel," by Chas. Hansel; "Successful Automatic Signals," by V. K. Spicer; "The Signal Department," by W. H. Elliott; "The Operation of Block Signals on a Single Track Railway," by W. A. D. Short; "Some Interlocking Devices," by A. H. Rudd; "Should One or Two Wires Be Used for Wire Connected Signals?" by Henry M. Sperry.

The Short Line War, by Merwin Webster; 12mo., cloth, pp. 334; illustrated. The Macmillan Co., 66 Fifth Avenue, New York. Price, \$1.50.

The author has succeeded in making a very readable novel out of a railroad fight in which a trunk line unsuccessfully attempts to seize a short line. The various characters are well drawn and there is no lack of incident. Indeed, the plot is highly exciting and interest is well sustained.

There is too much that is of the technical, however, to be pleasing to many superficial readers, and hardly sufficient accuracy and exactness in detail to satisfy the professional. Probably it will find readers chiefly among those who wish for entertainment along somewhat unusual lines.

Light and Power Installations for Private Residences and Hotels.—A most artistically prepared book has been issued by Messrs. Westinghouse, Church, Kerr & Company, New York, entitled "Light and Power Installations for Private Residences and Hotels." It is an advertising pamphlet well worth examination. The finest tinted paper, profuse and original illustrations, and a choice blending of colors, combine to present a business publication in a luxurious setting, coupled with the most refined taste. The pages are illustrated with artistic views of private residences and hotels where electric lighting is provided by Westinghouse gas engines and generators. We note that well-known people have substituted electric lighting for gas and lamps: Mr. Louis Marx, Alexandria Bay, N. Y.; Mr. W. Luttgen, Linden, N. J.; Mr. A. S. Apgar, Ridgefield, Conn.; Mr. Geo. J. Gould, Lakewood, N. J.; The Kirkwood Inn, Scarborough Beach, Maine; Mr. D. Le Roy Dresser, Oyster Bay, N. Y., and many others. We glean from the pages of this interesting book that electric lighting can be supplied in any remote point. The Westinghouse gas engine is a novel invention, specially adapted for electric lighting. Gasoline may be used as fuel when gas is not available. With an electric plant, light is supplied for the house, stables and grounds; and also power for operating pumps, elevator service, ventilating fans, lathes, saws, preparing fodder, ice freezers, dairy, laundry, and other work connected with private residences and hotels.

Record of Recent Construction, Baldwin Locomotive Works, No. 13.—This pamphlet in the valuable series issued by the Baldwin Locomotive Works was prepared to facilitate the various mathematical calculations necessarily involved in locomotive practice, the data being arranged in the form of graphic curves from which the desired results may be quickly obtained. The plates present curves for obtaining the number of revolutions of various sized driving wheels per mile run; piston speed in feet per minute at a speed of 10 miles per hour; the nominal

horse-power required for various speeds and grades; tractive power per pound of mean effective pressure, tractive power at 140, 160, 180 and 200 pounds boiler pressure; resistance in pounds per ton of train on various grades and various curves, and hauling capacity of locomotives.

The new illustrated catalogue of The Egan Co., Cincinnati, Ohio, is the most elaborate in its line that we have seen. It is 12½ by 9½ in size, and contains 340 pages. It is printed on fine enameled book paper, suitably bound in cloth, and lettered in gold. The introduction is not only in English, but is also printed in Russian, French, German and Spanish. This company have been endeavoring for several years to perfect and improve their line, so as to make it far superior and in advance of any other machinery, and they have brought out quite a number of new and advanced types of machines. This new catalogue shows all of these new machines and many more, so that no superintendent who wishes to keep in touch with the latest devices for turning out work can afford to be without one. The firm sends out these new catalogues, free of charge, express prepaid, and our readers are invited to write for them to J. A. Fay & Co., 516 to 536 West Front St., Cincinnati, Ohio.

Pneumatic Tools.—The Chicago Pneumatic Tool Co., 635 Monadnock Block, Chicago, have issued a special catalogue illustrating their exhibit at the recent conventions of the Master Mechanics and Master Car Builders' Associations at Old Point Comfort. This exhibit included all of the well known tools manufactured by this company and several new ones; the catalogue therefore presents the most recent practice. Among the new devices are the Henrikson flue cutter, long stroke riveters for rivets as large as 1½ inches in diameter, long stroke hammers for heavy clipping on steel plate, the No. 5 Whitelaw reversible boring machine which weighs but 10 pounds and will bore holes as large as 3 inches in diameter in wood, and the Cramp pneumatic rammer, which is used in the foundry of the Cramp yards in Philadelphia.

The Bullock Electric Manufacturing Co. send us a copy of their Bulletin No. 2,534, describing their engine type generators. This pamphlet of 10 pages, 8 by 10¼ inches in size, bears the date of August, 1899, and illustrates the construction of generators designed to meet the requirements of engineers for direct driving from either steam or gas engines or water wheels. These generators are compact and tasteful in outline. The pamphlet presents a detailed description of the features of the machines, the arrangement, the method of winding and the details of construction throughout. The pamphlet also contains line drawings of the generators, with tables of dimensions, speeds of revolution, capacity and weight.

Air Compressors.—The catalogues of the Ingersoll-Sergeant Co. have always contained the information which purchasers desire. A copy of the latest edition, known as the Air Compressor Catalogue No. 33, has just been received. A number of illustrations of important installations have been added, and the new edition includes an exhaustive series of formulas and tables on the flow of air through pipes. This information appears to be very valuable. It is evident that its preparation involved considerable expense, and many users of compressed air will appreciate it. The catalogue is indexed.

The Boston Belting Co. has issued a novel advertising device in the form of a series of pictures printed on a circular card 5 inches in diameter, which may be examined in succession through holes in covering discs arranged to be revolved about a central pivot. The pictures impress the desirability of buying only the best goods that are available, and they point to the losses which will be sustained by using cheap and inferior goods. The "cheap and nasty" plan is always a foolish one and particularly when applied to rubber goods.

Electric Mine Haulage.—A catalogue upon underground electric haulage has been issued jointly by the Baldwin Locomotive Works and the Westinghouse Electric & Manufacturing Company. Electric mine locomotives produced by such manufacturers cannot fail to interest all mine proprietors who study economy in operating expenses. The catalogue illustrates and describes the locomotives, and contains tables of dimensions, and of the hauling capacity upon various grades.

EQUIPMENT AND MANUFACTURING NOTES.

The Pressed Steel Car Co.'s pressed steel bolsters have been specified for 500 Illinois Central coal cars, and 200 Swift & Co.'s refrigerator cars, recently ordered.

The Chicago Grain Door Co. has received an order from the Chicago, Milwaukee & St. Paul Ry. for grain doors for 1,000 box cars which are to be built at the West Milwaukee shops.

Mr. G. E. Macklin, until recently Special Agent for the Pressed Steel Car Company, has been made Assistant General Sales Agent, with headquarters in the Empire Building, No. 71 Broadway, New York City.

The Illinois Central is soon to receive from the Brooks Locomotive Works a very large 12-wheel locomotive. The cylinders are 23 by 30 inches, the driving wheels 57 inches in diameter, the total weight, without tender, 218,000 lbs.

Mr. D. L. Markle has been appointed Assistant Manager of the Illinois Car and Equipment Co. He has charge of purchasing supplies and assists in the executive operation of the works. Mr. J. M. Maris is Manager and Mr. S. M. Dix, Treasurer.

The Niles Tool Works Co., of Hamilton, O.; the Pond Machine Tool Co., of Plainfield, N. J.; Bement, Miles & Co., of Philadelphia and the Philadelphia Engineering Works, of Philadelphia, have consolidated under the name of the Niles-Bement-Pond Co., with an authorized capital stock of \$8,000,000.

Mr. R. L. Gordon, for a long time with the Fox Pressed Steel Equipment Company, and more recently in the Chicago office of the Pressed Steel Car Co., has been transferred to the Wood's Run (Allegheny) plant of the Pressed Steel Car Company, where he will confine himself chiefly to engineering work.

The Reagan Grate Bar Co., 237 North Front Street, Philadelphia, have recently fitted seven of their Reagan grates to boilers of the Griswold Worsted Co. of that city, who write as follows: "We are burning bituminous coal with practically no smoke, and we do not have to clean fires with your grates. Since they were installed we have cut off one boiler. We consider this wonderfully good work and we are well pleased with our investment." This grate has been adapted by Mr. Reagan to locomotives and it is reported to be giving excellent service on the New York, New Haven & Hartford R. R.

The Babcock & Wilcox Company has sold to the Manhattan Elevated Railway Company, of New York City, the boilers required for its new electric generating plant, which will furnish electric current for operating its entire elevated railway system in New York City. The boiler equipment will consist of 64 520 H. P. Babcock & Wilcox all wrought steel boilers, capable of carrying a working pressure of 200 lbs. per square inch. The boilers will be fitted with Roney Automatic Stokers, manufactured by Westinghouse, Church, Kerr & Co. This is the largest single order ever placed for stationary boilers.

Postal cars are wanted in France. Consul Skinner, writing from Marseilles, July 6, 1899, said:

"I am advised that a project of law has been voted in this country upon the suggestion of the Under Secretary of State for the Department of Posts and Telegraphs, providing for the building of sixty-seven modern postal cars, each 13 meters (42 feet 7 inches) in length. The cars now in use follow a model adopted in 1857, and leave a great deal to be desired. The Government will naturally prefer to have the new cars constructed in this country, but, as the American postal cars have advantages greatly superior to anything known upon the Continent, it may be worth the while of American manufacturers to submit propositions."

The J. G. Brill Co. recently furnished an electric locomotive for use in the works of the Sandusky Portland Cement Co. The weight of the locomotive is 14,000 lbs. It is carried on two Brill trucks especially designed for such service. The locomotive

is 19 ft. long and about 4 ft. wide, while the track over which it is to run has a gauge of 2 ft. A small cab is provided for the motorman. The design is very simple. The two trucks and the frame connecting them and carrying the cab is practically all there is to the locomotive. The trucks have cast steel side frames and the truck bolster is supported upon helical springs in such a way as to give considerable side motion.

The Cleveland, Cincinnati, Chicago & St. Louis Ry. has ordered four large consolidation locomotives from the International Power Co. of Providence, R. I. They will have the following dimensions: Cylinders, 22 by 30 inches; 72 inch radial stay boilers; fireboxes 9 feet 11 inches by 3 feet 5 inches; tubes, 376 in number, 13 feet 8 inches long and 2 inches diameter; cast steel driving wheels, 56 inches diameter; tanks, 6,000 gallons capacity; Fox pressed steel tender trucks, and the engines will weigh in working order 190,000 pounds. This firm is also building 5 extended wagon top boilers and 16 Wooten firebox boilers for the Erie. The 22 locomotives for the Wabash are now being delivered and the entire order is expected to be completed early in September.

Mr. Adolph Janssens, of Paris and Brussels, has just returned from a trip to this country, where he purchased nearly \$200,000 worth of machine tools for export to France and Belgium. These orders were nearly all placed with Messrs. Manning, Maxwell & Moore of New York. In an interview published in the New York "Commercial," Mr. Janssens said: "Until recently I have confined my individual attention to the importation of English tools, but now I find that the tools made in this country are so vastly superior in every respect that I have decided to deal in American tools exclusively the moment my contracts run out. I shall soon return to this country to extend my trade in American machine tools. I am also anxious to return, so that I may extend my knowledge of American modes of manufacturing and operating various machinery."

The importance and volume of the business of the Pressed-Steel Car Company, entirely apart from the manufacture of pressed-steel cars, is not generally understood. The pressed-steel car is of comparatively recent development, that is, such cars have only been in use about three years. But the manufacture of pressed-steel bolsters, truck frames and centre plates, by the old Fox Pressed-Steel Equipment Co. and the Schoen Pressed-Steel Co., which two, combined, make the Pressed-Steel Car Company, has a history of more than ten years. Figures at hand for the past five weeks show a volume of business during that period above \$582,000, apart from car deliveries. The profits on this business are not given out, but its volume would seem to indicate the truth of the company's assertion that it is not far from forty per cent. of the total business done, and sufficient to alone pay much more than the seven per cent. required for the annual dividends on its preferred stock, of \$12,500,000.

The rapidity of the introduction of electric distribution of power and the wide field into which it is spreading is indicated by the following partial list of sales by the Bullock Electric Mfg. Co., of Cincinnati, Ohio, during July: Union Depot, Dayton, Ohio, 2 50-K. W. Engine Type Generators; Fuller Construction Co., New York City, 4 50-K. W. engine type generators; Wilson Aluminum Co., Holcomb Rock, Va., 1 60-K. W. belted generator; Warren K. Blodgett, Boston, Mass., 1 50-K. W. belted generator; American Type Foundry Co., Cincinnati, Ohio, 25 slow-speed motors for direct connection to type machines; D. E. Whitton Machine Co., New London, Ct., 1 30-K. W. belted generator; U. S. Government, San Francisco, Cal., 1 30-K. W. belted generator; Pullman Palace Car Co., St. Louis, Mo.; 1 12½-K. W. belted generator, 1 25-K. W. engine type generator; Daily Mail, London, England, 2 50-H. P. printing press equipments, Bullock "teaser control" system; Aldrich Mining Co., Brilliant, Ala. 1 30-K. W. belted generator; Missouri Lead & Zinc Co., Joplin, Mo., 1 20-H. P. motor; Boston News Bureau, Boston, Mass., 1 9-H. P. belted motor to run at a speed of 900 revolutions per minute; Hanover Mfg. Co., Bethlehem, Pa., 1 10-H. P. belted motor; Southern Electric Co., St. Louis, Mo., 1 18½-K. W. belted generator; Vulcan Metal Refinery Co., Sewaren, N. J., 1 17½-K. W. belted generator.

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HEAT TRANSMISSION IN LOCOMOTIVE BOILERS.

Material for Heating Surfaces.

Most Advantageous Lengths of Tubes.

By William Forsyth.

In the construction of the English locomotives recently built in this country, considerable freedom was allowed in the use of American details, and except in their external appearance the engines are in essential points not very different from our own. It is remarkable, therefore, that the English practice of using copper fireboxes and brass tubes has been strictly adhered to, resulting in a material increase in cost with no apparent advantage in efficiency over steel or iron plates and tubes.

Long continued practice and conservatism may be responsible for this, for English locomotive superintendents must be too intelligent to think they are getting a greater evaporative efficiency by the use of copper fire surfaces instead of steel. Without making a special investigation of the subject it is probable that many railroad men would give this as the most obvious explanation.

It may be useful, therefore, to give here some of the fundamental facts relating to heat transmission as applied to locomotive heating surfaces. It is necessary to distinguish between internal conduction and external transmission. The former is the transfer of heat between the particles of one continuous body. It varies with the heat conductivity, which depends upon the nature of the substance and is directly proportional to the difference between the temperatures of the two surfaces of the plate.

If silver be taken as the standard at 1,000, then rolled copper has a heat conductivity value of 845, steel 397 and wrought-iron 436. The internal conductivity of copper is therefore more than twice that of steel, but it must not be assumed, as is often the case, that a copper plate with hot gas on one side and water on the other will transmit twice as much heat to the water in a given time as a steel plate of equal thickness and temperature. For such conditions we have to deal with the external transmission of heat, and the laws governing it have not been exactly determined by experiment.

It is surprising that such important data relating to the physics of heat and that which has such frequent practical application has been the subject of only a few crude experiments. The results of those made on the evaporative action of different

portions of the heating surface of steam boilers indicate the general law that the quantity of heat transmitted per degree of temperature is practically uniform for various differences of temperatures. The transmission is accelerated by the mechanical impingement of gaseous products upon the plate. When the surfaces are perfectly clean, the rate of transmission of heat through plates of copper from hot gas to water is somewhat greater than for steel, but when the surfaces are dimmed or coated, as they always are in practice, the rate is the same for the different metals.

Within the limits used for fire surfaces in locomotive boilers the activity of transmission is not affected by the thickness of the plates. The record of tests recently made with two large stationary boilers, exactly alike, except that one had iron tubes and the other copper tubes, showed the evaporative efficiency to be practically the same. An excellent opportunity for a more interesting experiment was presented in these new English locomotives. If one of them had been built with a steel box and iron tubes, and careful measurements made of the evaporative efficiency as compared with a similar boiler with copper firebox and brass tubes, little, if any, difference would have been found, and it would set at rest the false ideas about the superior efficiency of copper. It would have also served a good purpose in determining the relative life and cost of repairs or fireboxes and tubes of such different materials.

The fact that the value of heating surface is independent of the material, and its thickness, is recognized in the revised code for boiler trials, recently reported to the American Society of Mechanical Engineers, where it is required that heating surface be measured on the side next the fire. The Serve tube is a familiar illustration of the fact that the fire side of heating surface is the valuable part which should be increased, and not the water side. If much improvement would have resulted from increased surface on the water side, tubes with ribs on the outside could have been much easier made and kept clean. But such an arrangement has not been seriously proposed.

The relative value of heating surface exposed to radiant fuel, as in a firebox, and that of the tubes which are only exposed to hot gases, has not been determined very accurately and the data relating to it are scanty. In the case of tubes the path of the gases is parallel to the walls of the tube, but in the sides of the firebox they strike the sheets at an angle and the amount of heat transmitted increases with the angle.

Laboratory tests of the efficiency of locomotive tubes under different conditions have already been made at the University of Illinois, as thesis work by a recent graduate. Some of the results obtained are as follows: A loss of 13.8 per cent. was found due to scale having a thickness of $\frac{3}{32}$ inch. For heat transmission alone the Serve tube, $2\frac{1}{4}$ inches outside diameter, was found to be 51 per cent. more efficient than a plain tube of the same outside diameter. The experiments with Serve tubes made on the Paris, Lyons & Mediterranean Railway demonstrates the fact that the same results are obtained with them as with plain tubes of equal diameter but twice the length. This suggested the use of shorter Serve tubes and that railway has found short Serve tubes and the short boilers required for them so advantageous that they now use Serve tubes only 9 or 10 feet long. It is likely, however, that when Serve tubes are introduced in this country it will be for the purpose of getting all the additional efficiency possible, and we do not believe that shorter boilers will be built, but that their size will continue to grow in all directions as it has in the past.

In regard to the ratio of length of tube to outside diameter, the present practice varies from 60 to 80, being as low as 60 on Continental compound express engines; on American express engines it is about 70, on British express engines 75, and on some six-wheel coupled Continental express engines as high as 80. In an extreme case, the Chicago, Burlington & Quincy Atlantic type engines with tubes 16 feet long and $2\frac{1}{4}$ inches diameter, the ratio is 85. Under similar conditions tubes

of different diameters will have the same efficiency if the ratio of length to diameter is maintained. The reason for this is that the number of molecules of hot gas in contact with the walls of the tube (that is, those which are transferring heat) increases as the circumference of the tube; but the number of molecules passing through the tube increases as the area of the cross-section of the tube. Consequently, in order to give up an equal amount of heat to the water, the length of tube must be increased in proportion to its diameter.

The experiments of Mr. Henry, Chief Engineer of the Paris, Lyons & Mediterranean Railway on the efficiency of tubes of various lengths were made with brass tubes $1\frac{1}{8}$ inches outside diameter, with lengths varying from about 10 to 23 feet. The ratio of diameter to length in the case of the 23-foot tube was 122. The experiments were carried on from 1885 to 1890, and the complete report, giving the results obtained, was published in the "Annales des Mines," 1894. A brief extract from this report, giving some of the principal figures bearing on our subject, was published in this paper September, 1899, page 289. They show that with the 10-foot tube the water evaporated per pound of coal was 7.87 pounds, and the smoke box temperature was 739° F. With the 23-foot tube the rate of evaporation was 10.20 pounds and the smoke box temperature 432° F. An increase of 130 per cent. in length of tube increased the evaporation 30 per cent. Within the limits of general practice the figures showing the effect of increasing a tube from 13 feet to 16 feet are more interesting. This increase of 23 per cent in length resulted in an increase in the rate of evaporation of 7 per cent. It should be understood that these data are only applicable to the conditions under which the experiments were made and which were really those of stationary boiler practice and not those under which locomotives are worked. The combustion of coal per square foot of grate per hour with the 10-foot tube was 38.2 pounds, and with the 23-foot tube only 28.9 pounds, which is only about one-fifth the amount burned on American express locomotives. As the quantity of coal burned per hour is increased, so also is the velocity of the gas passing through the tubes increased. With a velocity five times as great as that under which Mr. Henry's experiments were made, results would be obtained far different from those he has reported. While his experiments are considered classic in their way, we do not believe they have any general application in determining the efficiency of long tubes in locomotive boilers.

In the English edition of the "Bulletin of the International Railway Congress" there is a valuable paper on the "Efficiency of Tubes of Locomotive Boilers," by A. Wöhler, in which the author attempts to deduce by mathematics the effect of the velocity of the gas passing through a tube on the efficiency of the tube. For necessary data he has reference to Mr. Henry's experiments. In his discussion Mr. Wöhler explains that the effect of the molecules of gas in contact with the walls of a tube depends on the *velocity of the gas current* as well as its temperature, the period of contact of the molecules varying inversely as the velocity of the gas current. This velocity was calculated from the coal consumption and the mean air consumption given in Mr. Henry's reports, the product of the two giving the total amount of air which would pass through the tubes. The total amount of hot gas may be represented by this, as the difference is small. This divided by the product of the number of seconds and the total cross-section of the tube gives the velocity of the gas current. The interesting theoretical deductions which Wöhler makes from his mathematical treatment of the problem are given in a table which shows the proper ratio of length to diameter of tubes required to obtain different degrees of efficiency when the velocity of the gas currents vary from about 5 feet to 20 feet per second. While the maximum velocities given are much too low for application to modern locomotive practice, they call for tubes having a ratio of length to diameter of 100 where ordinary efficiency is expected, and 130 as a maximum where the velocity of the

gas is 20 feet per second. For 10 feet per second and ordinary efficiency, a ratio of 75 is required. The greater the velocity of the gas current the larger should be the ratio of length to diameter, and for the high velocities of gas in tubes of fast express locomotives it appears that it would not be practicable to use a plain tube long enough to obtain the maximum theoretical efficiency. The fact that high speed locomotives should have tubes as long as possible does not seem to be generally recognized, and we have endeavored to show why they are especially necessary for economy, where the velocity of the gas passing through them is so high.

If it is found to be a practicable thing to use tubes 18 to 20 feet long in a locomotive, it will be important to show by careful tests the economic value of each additional foot in length beyond 16 feet. The experiments of Mr. Henry, as we have shown, deal with rates of combustion entirely too low for our present purpose. The theoretical treatment of the subject by Mr. Wöhler points to the necessity of long tubes for high gas velocities. It now remains to show by careful measurements on a locomotive testing plant the value of long tubes when used with high rates of combustion.

The whole subject of heat transmission under conditions found in locomotive boilers is one which would form an interesting series of experiments for an engineering laboratory to undertake, and it is suggested to the enterprising professors who are extending the field of original research in connection with their regular courses of instruction.

The breakage of rails in track appears to be very infrequent, and it is reassuring to read the statements of well-known authorities in England in a recent discussion of the subject before the Institution of Civil Engineers. One said that on the Northeastern Railway, during a period of 25 years, the number of rails broken in the track averaged one in 3,500. Another gave the experience of the London & Northwestern for 12 years, during which time but 388 rails had broken, and yet without causing a single accident. Taking the average life of a rail on this road at 20 years he had found the average rate of breakage to be 1 in 2,000. From particulars given by Mr. Footner, the speaker last referred to, it was seen that "neither the age nor the weight of the rail, nor the amount of traffic, nor the influence of the seasons, nor the position in curves and tangents, nor the action of brakes or trains starting, took any such leading part as to justify the assumption that any of them determined the fractures." The discussion tended to show that the speakers did not see any reason to believe that a worn rail was any more likely to break, except from weakness due to the section having worn down, than a new one. "In this respect," says "Engineering News," in commenting upon the discussion, "we believe that English experience coincides with the American. The increase in weight of rolling stock in this country has been kept pace with by the increase in the weight of rail sections, and so far as our knowledge extends, rail breakages are, if anything, less frequent now than they were 20 years ago."

Superheated steam offers a number of advantages which are summed up by Mr. R. S. Hale in "The Engineering Magazine" as follows: 1st. A slight gain at the boiler, although a less gain than can be obtained by increasing the boiler heating surface, or by the use of an economizer. 2d. A large gain in economy at the engine, while as a disadvantage there is: 3d. An increased loss in the steam pipes, due to increased radiation, fall of pressure and increased leaks. With from 500 to 700 degrees temperature of the steam, Mr. Hale places the results to be obtained as follows:

Gain at boiler	2 per cent.
Gain at engine	10 to 20 per cent.
Extra loss in pipes	$4\frac{1}{2}$ per cent.
Net gain	$7\frac{1}{2}$ to $17\frac{1}{2}$ per cent.

AN AMERICAN OBSERVER ABROAD.

I.

England.

Professor W. F. M. Goss.

Editor American Engineer and Railroad Journal:

Your suggestion that I write a few letters to home friends for delivery through the columns of the American Engineer has, as you see, proved over-alluring. A reader may so easily dispose of a printed letter—may read it, scan it hastily, pass it over altogether, certainly need never answer it—as to make it clear that I shall lay a burden on no one by writing; at least on no one except the editor, and editors have effectual methods of relief.

To properly understand his English experiences, an American should occasionally pass in review the great procession of his fellow countrymen who have preceded him. By so doing he will the more readily see how it is that he is everywhere recognized as an American, why porters prefer carrying his luggage to that of his English fellow passengers, and why shop keepers in response to his inquiry for wares voluntarily reduce their shilling prices to a dollar basis.

An Englishman whom I met by chance one day in Scotland assured me that "Americans in England can have anything they want," a statement which I, with my capacity for wanting things, was somewhat inclined to doubt. He insisted upon his view, however, and illustrated it by an incident of his own journey. In Edinburgh, a few days before, he had attempted to see Holyrood Palace, but had been met with the statement that the building was closed for repairs. To this he replied that he had travelled a considerable distance for the purpose of seeing the place; that he could not remain in Edinburgh until the repairs were completed, and that he had made his present visit in conformity with the advertised statement concerning the admission of visitors. He urged, therefore, as a special favor, to be shown through the building. To this rather stirring appeal the attendant is reported to have said:

"I am very sorry. If you were an American it could probably be arranged. But it will be quite impossible for an Englishman to be admitted to-day," a statement which he, an English taxpayer, considered interesting and suggestive, but, on the whole, rather discriminating.

Besides what was gained from the fact of being an American, and therefore privileged, I enjoyed many opportunities for which I am indebted to engineering friends at home. Some had given letters of introduction, which, when presented, brought forth a most cordial response. Others had in past years been admirable and well-remembered hosts to English travelers in America, and I had the good fortune to be accepted as a representative of some of these entertainers, and to receive courtesies which I enjoyed as thoroughly as though I had earned them all.

I was impressed by the many complimentary expressions concerning Americans and things American. The manager of a large manufacturing company whom I first met in London, assured me that when I should visit him I should find a shop which probably was more nearly American "than any other in England." Later, when I had seen his works and observed the excellence of their equipment and the completeness of their system of manufacture, I realized with what praise he had spoken.

I did not visit any large establishment that had not some machines of American manufacture. They were always pointed out and their satisfactory performance was generally the subject of comment. In an extensive railway shop where only one American tool was exhibited, the information was volunteered that others were ordered and many more were in prospect.

The American locomotive in England was often discussed. I never introduced the subject, but there were few engineers with whom I had any considerable conversation who did not

refer to it. Men associated with railways in mentioning the matter sometimes exhibited circulars of information from agents of American builders and laughingly remarked that it was easy enough to buy locomotives if one chanced to be in need, while outside engineers often talked in a strain which indicated that they looked upon the advent of our locomotives as an epoch marking incident; as the initial step in a process which in some way is to make for the increased convenience and comfort of the English traveling public. To what extent this vision is warranted I am not prepared to say, but it is clear that its existence is a tribute to the energy and skill with which American engineers have wrought. The business significance of the situation is admitted by all. Some say, a few locomotives more or less in England is not a matter of importance, "but how about the control of our colonial and other foreign markets?"

None of the American engines had been put in operation at the time I left England, though I understood that the first shipment was nearly ready for service. I have since heard nothing as to their performance, but I am sure that whatever the official judgment may be, the public acclamation will approve the engines.

Englishmen, however, are not inclined to so exalt American industry as to think lightly of their own, but it is as pleasurable as it is just to emphasize the readiness with which they give expression to their feelings of appreciation. A well-informed gentleman, in speaking of the matter, summarized the situation by saying: "The fact is that the present generation of Englishmen has always been kindly disposed toward Americans, but until your Spanish war gave us a chance to serve you, Americans haven't believed it."

The history of England is well told in the monuments to her great men. Her victories on land and sea, the development of her literature, and her progress in civil liberty are written in bronze and stone memorials all over the land. In remembering her great warriors and statesmen she has not forgotten her engineers. As one travels about he frequently comes upon tributes to Watt and the two Stephensons—men who, though pioneers, have left an impress so clear that a century of progress has left it unobscured.

One sees here many traces of an earlier engineering practice. It is wonderful how by repeated repairing, or by occasional modification in form to meet the requirements of a changed external condition, an old machine or an old design may be made to render service. A locomotive built forty years ago was pointed out with evident pride as "still working regularly in fast express passenger service." The usual form of freight car brake now in use is substantially the same with that operated by George Stephenson when, as a boy, he rode colliery cars down an incline. The present gear, however, is of iron and acts upon all four wheels of the car, while the brake of Stephenson's day was of wood and acted upon a single wheel only. The present arrangement consists of a rocker shaft located underneath the center of the car and extending across its full breadth. This carries four short arms, each of which connects with a brake-head acting upon one of the wheels of the car; and attached to one end is a long arm or handle extending along the length of the car nearly to the end, by means of which power is applied. In release the handle is hooked in a position nearly horizontal; for service application it is unhooked and allowed to drop, its weight being sufficient to produce the desired brake shoe pressure; and for emergency the attendant follows up a service application by standing on the handle. The brake is serviceable for yard work only, the attendant running beside the car except during an emergency application, and except when the cars are switched too fast for him, in which case the braking is entirely omitted. The light weight of the cars and the excellent character of the buffers with which they are fitted make the braking of cars of much less consequence than in American service.

W. F. M. GOSS.

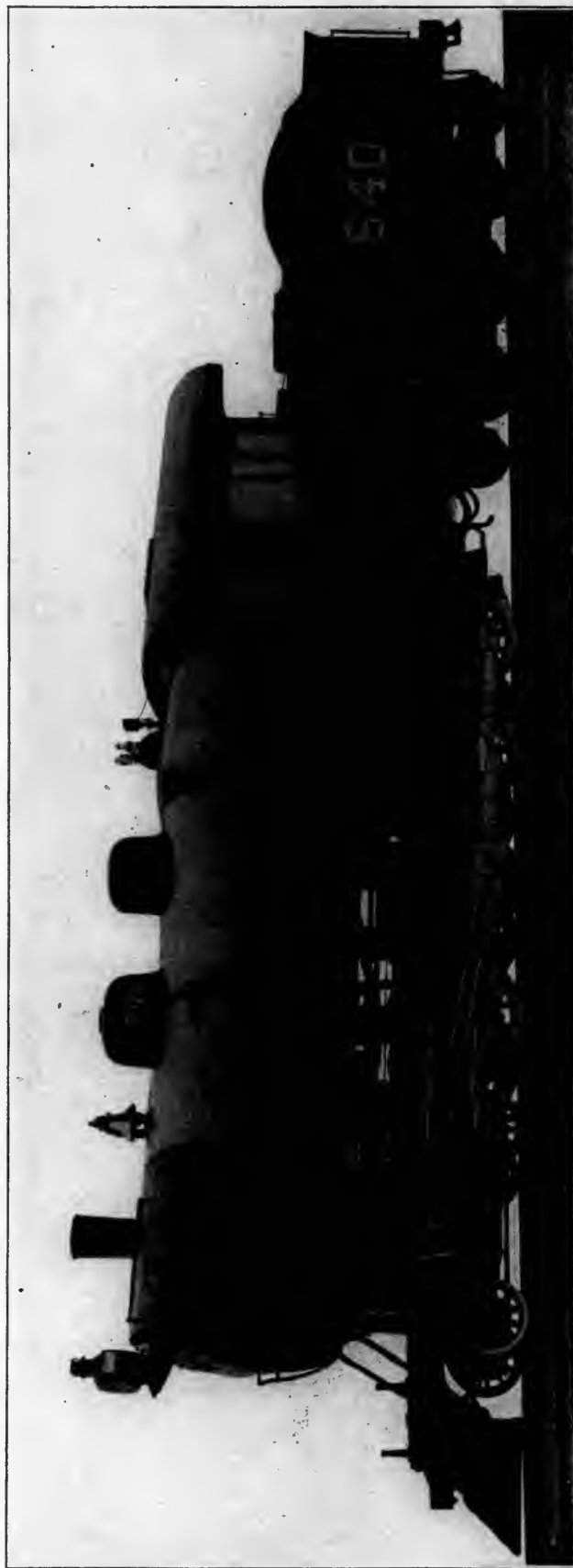
Dresden, August 30, 1899.

CORNELIUS VANDERBILT.

Cornelius Vanderbilt died at his home in New York, Tuesday, Sept. 12th, from a stroke of paralysis. He was the head of the Vanderbilt family and until about three years ago was in active charge of the enormous Vanderbilt railroad interests. At that time he suffered from a paralytic shock. The daily papers have given such complete details of Mr. Vanderbilt's career as to render it unnecessary to repeat them here. It is sufficient to say that he inherited a vast estate, which he doubled in value, and that in the height of his activity he held important offices in about 45 different railroads. Mr. Vanderbilt was born at New Dorp, Staten Island, in 1843. He was the eldest son of Wm. H. Vanderbilt and grandson of Cornelius Vanderbilt, who laid the foundation for these famous properties. In spite of the exacting nature of his self-imposed work in increasing the value of the fortunes left him, Mr. Vanderbilt found time from the business hours of every day to give to the welfare of others. The New York Central and other Vanderbilt lines have profited, and will continue to profit for years to come, by his generous support and active interest in establishing wholesome surroundings for the men when off duty in connection with the railroad branch of the Young Men's Christian Association. The very fine building near the Grand Central Station, New York, which he built and equipped for the use of the employees of the New York Central Railroad, will be an enduring memorial of his generosity. He was a thorough believer in the idea of surrounding the employees with good influences inspired by Christian motives. The religious side of Mr. Vanderbilt's life was an important one and there is no doubt that a great many worthy objects received financial support from him in a quiet way.

Rails 60 feet long have several theoretical advantages over shorter ones, among which is the saving in the number of joints necessary to instal and maintain. At the recent convention of the Roadmasters' Association the discussion seemed to indicate that the practical objections to their use are serious, and it is certain that the use of long rails is not increasing. Roads having put in experimental sections of 60-foot rails are not placing further orders for long ones. The chief difficulties are: 1st, the long rails are hard to handle; 2d, they are not properly straightened at the mills; 3d, they require large openings between their ends to allow for expansion in the track; and, 4th, they require much more labor to keep the track in good condition as to surface. Rails 33 feet long were more favorably considered. They afford a reduction of 10 per cent. in the number of joints and are not much more difficult to handle than those of the usual length of 30 feet. The committee reporting on the subject recommended a length of 33 feet.

The punching of rivet holes in boiler sheets is usually condemned as unsafe unless the distressed material immediately around the hole is removed by reaming. Mr. T. R. Browne, Master Mechanic of the Pennsylvania Railroad at the Juniata shops in Altoona, in discussing the construction of boilers before the New York Railroad Club, recently, directed attention to an important matter concerning the use of punched sheets, which is not probably well understood. Mr. Browne said: "Where the practice of punching sheets flat is followed, the hole should be punched from that side of the sheet which will be on the outside of the curve when the sheet is rolled; in other words, that portion of the sheet which is on the inside of the curve when it is rolled should be next to the female die. We have known side sheets to be very seriously cracked through the rivet holes owing to the fact that the holes were punched in such a way that the fin side of the hole came on the outside of the curve and the strain on the fin, or thin edge of the hole, was sufficient to start the crack. Where it is not possible to punch the holes in this way without extra handling, these fins should be removed before the sheet is punched."



TWELVE-WHEEL FREIGHT LOCOMOTIVE—ILLINOIS CENTRAL R. R.

12-WHEEL FREIGHT LOCOMOTIVE.

Illinois Central Railroad.

Built by the Brooks Locomotive Works.

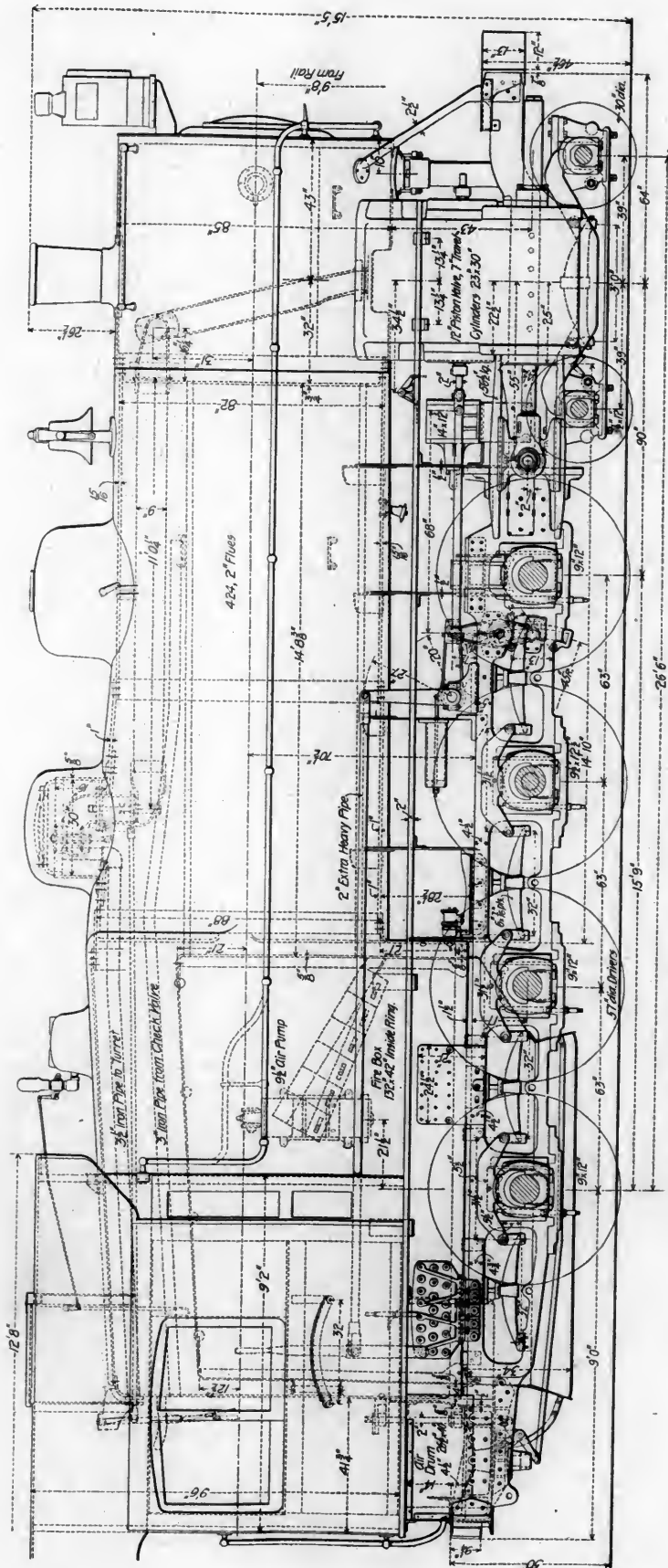
The Heaviest Locomotive Ever Built.

The Illinois Central Railroad has now the record locomotive as to total weight, and the builders of the engine, described here, believe that this marks the limit of weight, which will not be passed for some time. It is bold to predict what the locomotive of the future is to be, particularly in regard to weight and power. It is safe to say, however, that if the limit of weight is now reached, that of power is not and will not be until a number of fruitful resources, now almost untouched, are exhausted. Great weight is, of course, necessary in securing high tractive power, and that designing is best which furnishes the greatest amount of train-hauling capacity with the least total weight. An interesting view of the ideas of various roads and locomotive builders as to how to attain the most satisfactory results is presented in the table herewith, which contains a comparison of the chief characteristics of recent heavy locomotives. In comparing these designs the special conditions which each is intended to meet must be considered, and these are included in the descriptions of the locomotives, as far as it is possible to do so.

It may be interesting to have attention called to some of the leading characteristics of this design, although they are included in the table of dimensions.

The boiler pressure of 210 pounds calls for a strong boiler and unusually thick sheets. The thickness of the barrel plates is 15/16 and 1 inch, the back tube sheet is 3/4 inch, the crown is 7/16 inch, the front tube sheet 5/8 inch, and the side and back firebox sheets are 3/8 inch. The mud ring is 4 inches wide at the back and front and 3 1/2 inches at the sides, the water spaces at the top being 5 inches at the back, 7 1/2 inches at the sides and 4 inches at the front. The diameter of the boiler at the front end is 82 inches and at the throat 91 1/4 inches, the boiler being of the Player belpaire wagon top form, with sextuple lap horizontal seams and triple lap circumferential seams. The firebox is 132 by 42 inches inside the mud ring, and the grate area is 37 1/2 square feet. There are 424 two-inch tubes 14 ft. 8 3/4 in. long over the flue sheets. The tube heating surface is 3,237 square feet, and with the exception of the Baldwin compounds for the Lehigh Valley (American Engineer, December, 1898, page 395), this is the largest number of tubes of which we have record. The brick arch is supported on studs. The front end arrangement includes Mr. J. Snowden Bell's spark arrester.

The driving wheels are of cast steel and 57 inches in diameter; they have flanges throughout. The cylinders are 23 by 30 inches; they are of the same diameter as those of the Union Railway locomotive (issue of November, 1898, page 365), and 2 inches shorter stroke. The piston rods are extended. The



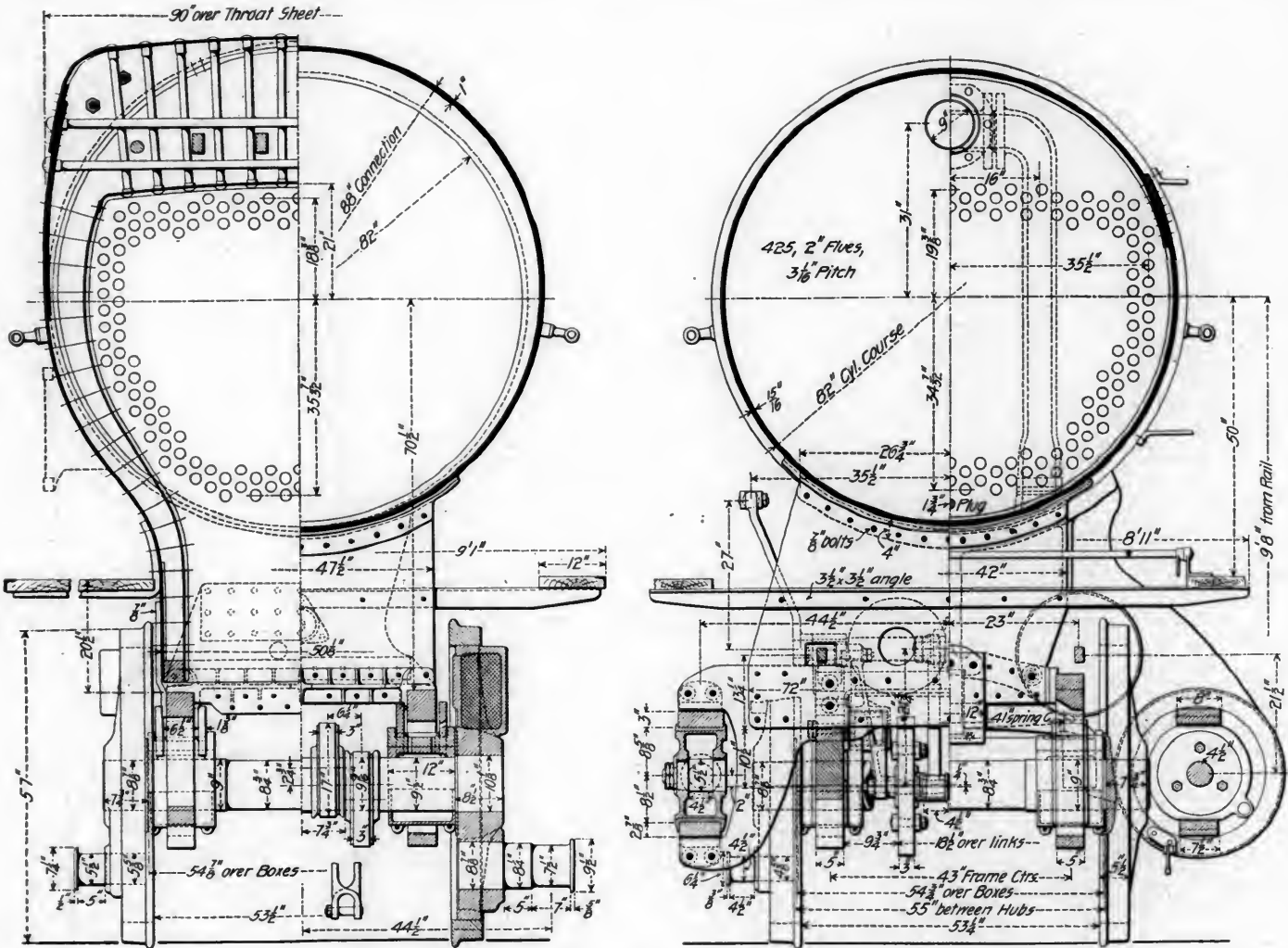
TWELVE-WHEEL FREIGHT LOCOMOTIVE—ILLINOIS CENTRAL RAILROAD.

The Heaviest Locomotive Ever Built.

BROOKS LOCOMOTIVE WORKS, BUILDERS.

W. RENSCHAW, Superintendent of Motive Power.
W. H. V. ROSING, Mechanical Engineer.

This Locomotive was Designed to Haul a Train Weighing 2,045 Tons up a 38-Foot Grade, with Curves of 3 Degrees, at 15 Miles per Hour.



Twelve-Wheel Freight Locomotive—Illinois Central R. R.—Transverse Sections.

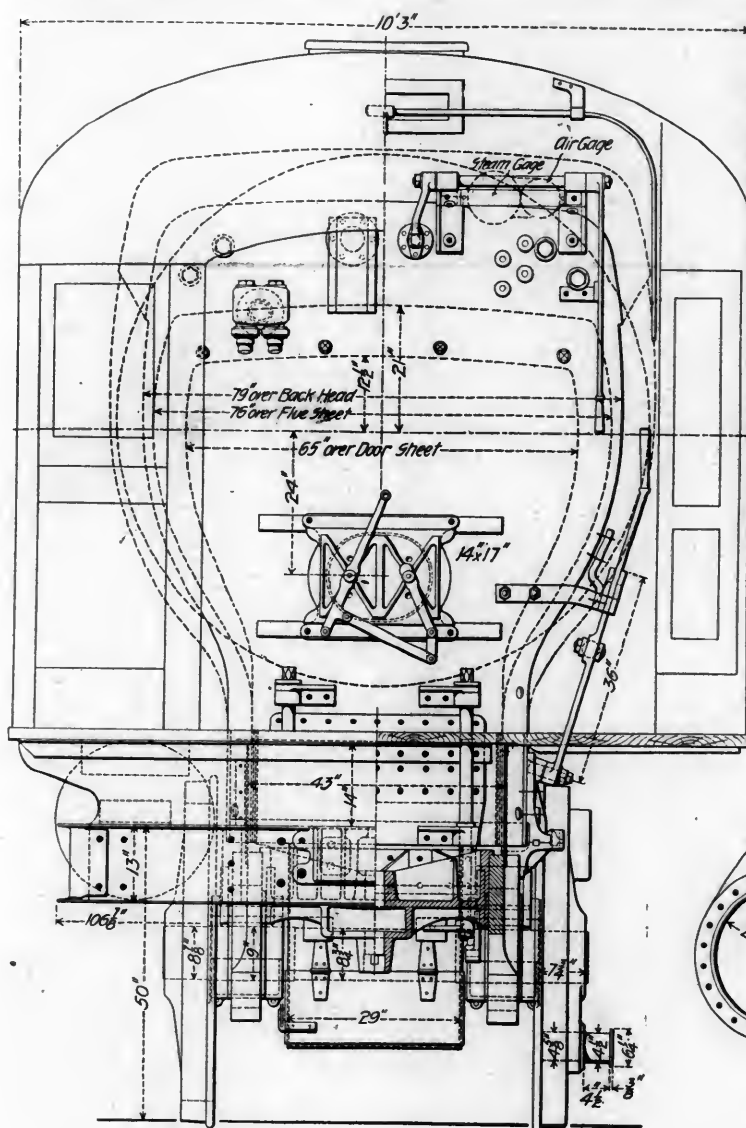
Leading Characteristics of the Heaviest Modern Freight Locomotives.

Railroad	Union.	Lehigh Valley.	Illinois Central.	{ Pennsylvania } Class H5. P. R. R. Simple.	So. Pacific.	Gt. Northern.	B. & M. R.
Builder	Pittsburgh.	Baldwin.	Brooks.	{ Pennsylvania }	Schenectady.	Brooks.	Pittsburgh.
Simple or compound ..	Simple.	Vauclain Comp'd.	Simple.	P. R. R.	Compound.	Simple.	Simple.
Type	Consolidation.	Consolidation.	12-Wheel.	Consolidation.	Consolidation.	12-Wheel.	Consolidation.
Total weight.	230,000 lbs.	225,082 lbs.	232,200 lbs.	198,000 lbs.	193,000 lbs.	212,750 lbs.	181,200 lbs.
Weight on drivers.	208,000 lbs.	202,232 lbs.	193,200 lbs.	176,000 lbs.	173,000 lbs.	172,000 lbs.	166,000 lbs.
Size of drivers	54 in.	55 in.	57 in.	56 in.	57 in.	55 in.	52 in.
Size of cylinders	23 x 32 in.	18 and 20 by 30 in.	23 x 30 in.	23 1/2 x 28 in.	23 and 35 by 34 in.	21 x 34 in.	22 x 28 in.
Heating surface	3,322 sq. ft.	4,103.6 sq. ft.	3,500 sq. ft.	2,721 sq. ft.	3,027.8 sq. ft.	3,280 sq. ft.	2,675 sq. ft.
Firebox size	120 x 40 1/4 in.	120 x 108 in.	132 x 42 in.	120 x 40 in.	126 x 40 3/8 in.	124 x 40 1/4 in.	114 x 40 in.
Grate area	33.5 sq. ft.	90 sq. ft.	37.5 sq. ft.	33.3 sq. ft.	35.3 sq. ft.	34 sq. ft.	31.6 sq. ft.
Steam pressure	200 lbs.	200 lbs.	210 lbs.	185 lbs.	220 lbs.	210 lbs.	180 lbs.
Size of boiler	80 in.	80 in.	82 in.	71 in.	72 in.	78 in.	74 in.
Tubes, number and size	355—2 1/4 in.	511—2 in.	424—2 in.	306—2 1/4 in.	332—2 1/4 in.	376—2 1/4 in.	292—2 1/4 in.
Tubes, length	15 ft.	14 ft. 7 3/4 in.	14 ft. 8 3/4 in.	14 ft.	14 ft. 6 in.	13 ft. 1 3/8 in.	14 ft. 6 1/2 in.
Description in American Engineer and Railroad Journal. .	November, 1898. Page 365.	December, 1898. Page 395.	This issue.	June, 1899. Page 177.	May, 1899. Page 150.	January, 1898. Page 1.	September, 1898. Page 206.

valves are of the piston type, 12 inches in diameter, with 7 inches stroke and the arrangement of the packing rings is new in locomotive practice in connection with valves of this type, although it has been in general use in marine practice. The packing rings are about 3 inches wide and made in a single piece, which is split, forming a joint for the reception of a shim, the thickness of which may be increased to compensate for the wear of the valve bushing. The ring is closed against the shim by a bolt passing through lugs cast on the inside of the ring. When thus secured, the ring can not be enlarged by internal pressure of steam, and this arrangement appears likely to overcome the difficulties which have been experienced with piston valve packing rings, because it avoids the necessity for securing tight fits of the rings where they are held by the fol-

lowers, and it does not matter whether steam gets under the rings or not. Of course the rings must make close fits with the bushings in order to prevent leakage, and the adjustment made by means of the shims must be accurately done. It will, possibly, be necessary to ream the valve bushings after they have been placed in position in the valve casing. Piston valves seem to be specially desirable, if not absolutely necessary, with such large cylinders and such high pressures. To guess the weight of piston valves of this size it would be put at about 200 pounds, and a slide valve would be much heavier for steam ports 28 inches long.

The arrangement of the valves, the frames and equalizers may be seen in the engravings. The front sections of the frames are in the form of single bars 4 by 9 inches in section, with an



Rear Elevation and Section.

upward bend toward the bumpers. Lateral bracing is provided between the frames at the forward drivers, at the front of the firebox and at the back ends. The depth of the upper bar of the double bar frame varies; it is 5 inches between the first and second pairs of drivers, 4½ inches between the second and fourth and 4¾ at the rear of the fourth pair up to the rear expansion pad, where it takes the slab form, which continues to the back end. The frames are 5 inches wide. The boiler is supported at four points between the cylinders and the firebox by braces of ½-inch plate, three of which also support the running boards, which are flush with the cab floor.

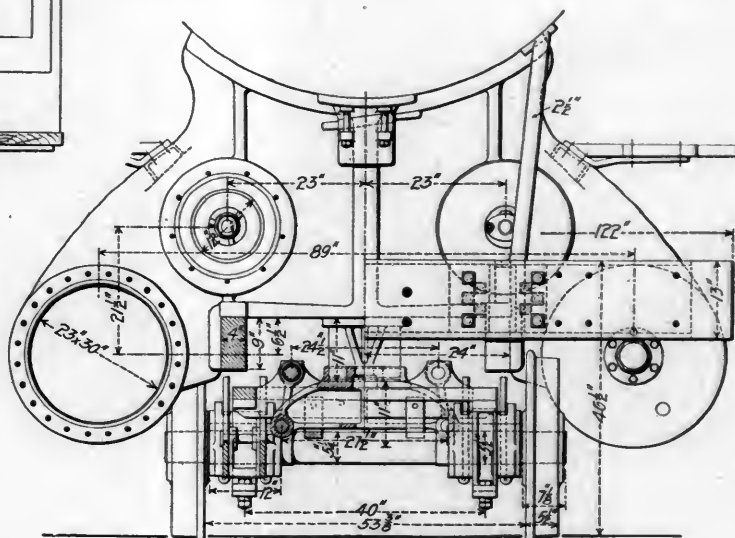
The main driving axles and crank pins have enlarged wheel fits, as will be seen in the transverse sectional views of the engine. This practice is to be commended and it is hoped that in future designs the other driving axles will receive the same treatment, especially in view of the fact that there appear to be no objections to such an enlargement. The driving journals are 9 by 12 inches, except the main pair, which are $9\frac{1}{2}$ by 12 inches. The section through the guides shows them to be large, the upper bar is 8 to 3 inches, and the lower one $7\frac{1}{2}$ by $2\frac{3}{4}$ inches. This view also clearly shows the directness of the valve connections between the links and the valve stems. The rocker arms are both inside the frames. The brake cylinder is placed back of the saddle, and the brake shoes are placed back of the driving wheels, which causes the hangers to push upward against the frames when the brakes are applied; this prevents the serious addition to the load on the springs, which

would be imposed by brake hangers that would pull down, as is the case when the shoes are placed in front of the drivers.

The tender has a capacity of 7,000 gallons of water and 12 tons of coal, yet it does not look large when coupled to such an enormous locomotive. It is carried on Fox pressed steel trucks with double elliptic springs and 5 by 9 inch axles. The weight of the tender loaded is 132,700 lbs. The following table gives a summary of the important dimensions:

General Dimensions.	
Gauge.....	4 ft. 8½ in.
Kind of fuel to be used.....	Bituminous coal
Weight on drivers.....	193,200 lbs.
Weight on trucks.....	39,000 lbs.
Weight, total.....	232,200 lbs.
Weight, tender, loaded.....	132,700 lbs.

General Dimensions.	
Wheel base, total, of engine	26 ft. 6 in.
Wheel base, driving	15 ft. 9 in.
Wheel base, total, engine and tender	55 ft. 2½ in.
Length over all, engine	42 ft. ¾ in.
Length over all, total, engine and tender	65 ft. 7½ in.
Height, center of boiler above rails	9 ft. 8 in.
Height of stack above rails	15 ft. 5 in.
Heating surface, firebox	263 sq. ft.
Heating surface, tubes	3,237 sq. ft.
Heating surface, total	3,500 sq. ft.
Grate area	37.5 sq. ft.



Section and Elevation at Cylinders.

Wheels and Journals.	
Drivers, diameter	57 in.
Drivers, material of centers	Cast steel
Truck wheels, diameter	30 in.
Journals, driving axle, main	9½ in. by 12 in.
Journals, driving axle, others	9 in. by 12 in.
Journals, truck	5½ in. by 12 in.
Wheel fit, main	10½ in. by 8½ in.
Main crank pin, size	7½ in. by 7 in.
Main coupling pin, size	8½ in. by 5 in.
Main pin, diameter wheel fit	87½ in.

Cylinders.	
Cylinders, diameter .....	.23 in.
Cylinders, stroke .....	.30 in.
Piston rod, diameter .....	.12 in.
End of piston rod packing	1/2 in.
Man rod length center to center .....	.98 in.
Steam ports, length .....	.28 in.
Steam ports, width .....	.21 in.
Exhaust ports, least area .....	.110 sq. in.
Bridge, width .....	.312 in.

Valves.	
Valves, kind of	Improved piston
Valves, greatest travel	7 in.
Valves, steam lap (inside)	1/4 in.
Valves, exhaust lap or clearance (outside)	Line and line
Lead in full gear	1/16 in. negative
Lead, constant or variable	Variable

Boiler.	
Boiler, type of	Player belpaire wagon top
Boiler, working steam pressure	210 lbs.
Boiler, material in barrel	Steel
Boiler, thickness of material in barrel	15/16 in. and 1 in.
Boiler, thickness of tube sheet	3/4 in.
Boiler, diameter of barrel, front	82 in.
Boiler, diameter of barrel at throat	91 1/2 in.
Seams, kind of horizontal	Sextuple, lap
Seams, kind of circumferential	Triple, lap
Crown sheet, stayed with	Direct stays
Dome, diameter	30 in.

Firebox.

Firebox, type	Long, over frames
Firebox, length	132 in.
Firebox, width	42 in.
Firebox, depth, front	90 in.
Firebox, depth, back	81½ in.
Firebox, material	Steel
Firebox, thickness of sheets.....	Crown, 7/16 in.; tube, 5/8 in.; side and back, 3/4 in.
Firebox, brick arch	On studs
Firebox, mud ring, width.....	Back, 4 in.; sides, 3½ in.; front, 4 in.
Firebox, water space at top.....	Back, 5 in.; sides, 7½ in.; front, 4 in.
Grates, kind of	Cast iron rocking
Tubes, number of	424
Tubes, material	Charcoal iron
Tubes, outside diameter	2 in.
Tubes, thickness	No. 12 B. W. G.
Tubes, length over tube sheets.....	14 ft. 8½ in.

Smokebox.

Smokebox, diameter outside	85 in.
Smokebox, length from flue sheet	75 in.

Other Parts.

Exhaust nozzle, single or double.....	Single
Exhaust nozzle, variable or permanent.....	Permanent
Exhaust nozzle, diameter	5½ in.; 6½ in.
Exhaust nozzle, distance or tip below center of boiler.....	7 in.
Netting, wire or plate	Wire
Netting, size of mesh or perforation.....	2½ in. by 2½ in. and 2½ in. by 1½ in.
Stack, straight or taper	Steel, taper
Stack, least diameter	15¼ in.
Stack, greatest diameter	17¾ in.
Stack, height above smokebox.....	26½ in.

Tender.

Type	8-wheeled
Tank, capacity for water	7,000 gal.
Tank, capacity for coal	12 tons
Tank, material	Steel
Tank, thickness of sheets	¾ in.
Type of under frame	Oak
Type of springs	Double elliptic
Diameter of wheels	33 in.
Diameter and length of journals.....	5 in. by 9 in.
Distance between centers of journals.....	5 ft. 3 in.
Diameter of wheel fit on axle.....	6½ in.
Diameter of center of axle	5½ in.
Length of tender over bumper beams.....	24 ft. 0 in.
Length of tank	22 ft. 0 in.
Width of tank	10 ft. 0 in.
Height of tank, not including collar.....	72 in.
Type of draw gear	M. C. B. Thurmond

THE PHILADELPHIA EXPORT EXPOSITION.

This enterprising exposition, which has already been referred to in these columns, was opened September 14, with appropriate ceremonies.

This is the first exhibition of the kind to be held in this country. Its purpose is to spread knowledge of our mechanical and agricultural industries and products throughout the markets of the world with a view of extending and increasing our exports. During the last few years these have been increasing enormously and a much greater development is expected from a better understanding on the part of the outside world of our facilities and resources. In short, the exposition is intended to create a demand for American products, and one of the notable features will be an industrial congress, to which representatives of foreign trade organizations have been invited. We are informed that more than a thousand of these delegates have already accepted and a great deal is expected from the information and impressions they will receive.

The exposition is arranged on a large scale with three central buildings, the chief of which covers more than 12 acres of space, while the others are not as large. This enterprise promises to be very important and useful. It is well located and we believe that the exposition opens with no debt on the buildings.

While the primary object is to give foreigners a proper conception of the advantages of buying goods in this country, another important part of the project is that which serves to instruct our manufacturers in what they very much need to know of the foreigners' requirements, not the least important of these being in methods of packing and shipping goods for the satisfaction of the consignees and the customs authorities.

Steel ties have not been satisfactory on the New York Central. "Engineering News" states that the experimental section at Garrisons, N. Y., laid with Hartford's steel ties ten years ago, has given a great deal of trouble in getting out of line and also out of surface. The ties have proved durable, but they are expensive in maintenance of track. They also increase the noise of trains in passing over them on account of the rattling of the stone ballast and the bolts.

THE PRINCIPLES OF CAR TRUSSING.

By O. H. Reynolds.

With all of the timely suggestions made with a view to improvement in the details of car construction, there appears to have been no attempt to establish definite practice in the location of cross-tie timbers or depth of trusses for similar conditions—at least, there is nothing bearing on this question in car literature that has happened to come to our attention. Possibly the reason for this is that the matter is considered of too little importance to merit much attention; in fact, the absence of systematic treatment warrants that conclusion, for there is quite enough diversity in practice (that should follow well defined lines) to indicate either a want of interest or information, or both.

The degree of importance attached to the points of design named is best explained by the statement that sills, even though trussed, are in the best condition to carry their load when supported so as to give three equal panels or spaces between the body bolsters. The reason for this is obvious, since sills are simply beams, and they are frequently made to carry loads that cannot properly be called distributed, and in such cases the car framing is weak at the part having the longest distance between supports. With three equally spaced divisions between the body bolsters, it is necessary to proportion the sills to carry, unaided, the distributed load between cross-ties, and also between cross-ties and bolsters; when sills are so designed they are strong enough to withstand all other stresses brought to bear on them.

In the proposed division of the sills into three panels it is seen that the cross-ties have a definitely assigned location and



The Principles of Car Trussing.

distance apart that is always proportioned to the distance between bolsters. With this distance for a base it is an easy problem to give the truss rods such a drop as to keep the fiber stress within the requirements, and it is this matter of depth of truss that is vital after the location of cross-ties has been decided on. This is illustrated by the accompanying stress diagram of a 60,000 pound car—which is shown without the superstructure, as that has no bearing on the subject in hand.

This car is 36 feet long, and has six sills, and four 1½ inch truss rods. The weight of the body is 18,000 pounds, and with the rated capacity, the load to be carried by the bolsters is 78,000 pounds, or 2,166 pounds per foot. The load supported at the several points is shown above the sills, together with the amounts coming directly on the bolsters, and also those transmitted to the bolsters by truss rods. In this arrangement we find a fiber stress of 13,000 pounds per square inch on each truss rod; there is a pull of 19,000 pounds to produce this stress, and there is also a horizontal component due to this pull equal to 18,785 pounds on each rod, which must be provided for at the end sill.

The effect of an unsymmetrical disposition of the cross-ties by making them 6 feet 8 inches between centers, with all other conditions remaining the same, is to put a fiber stress of 14,417 pounds per square inch on each rod, and increase the pull to 21,414 pounds, with a resulting compression of 20,938 pounds on the end sill under each rod. The fiber stress is thus increased nearly 1,500 pounds, due to the movement of the truss rod support one foot nearer the center of the car. There are two remedies to choose from to reduce this fiber stress—one is to make a deeper truss, and the other is to increase the diameter of the rods; if the latter is done, it will require 1½ inch rods, which will reduce the stress to 12,160 pounds per

square inch, with a corresponding reduction of the stress at the end sill. This is a procedure often followed, but it is fallacious, as will be shown.

Returning to the diagram, and leaving all dimensions as they stand, except the depth of truss, and making that 30 inches instead of 24 inches, it can be shown that $1\frac{1}{4}$ -inch rods may be used, which will give a fiber stress of 12,800 pounds per square inch and a horizontal component of only 15,000 pounds. It is evident that increasing the truss is a more advantageous method of reducing the fiber stress than to increase the size of the rod, but there are still other advantages in the increased truss, one of which is the weight of the $1\frac{1}{4}$ -inch rods of 616 pounds per car against 724 pounds for the $1\frac{3}{8}$ rods, which is an item worth considering, and the other advantage is the price, which will be, roughly, \$18 for the set of $1\frac{1}{4}$ -inch rods and \$29 per set for the $1\frac{3}{8}$ -inch rods. The deep truss also opens the way to a deep section for the cross-tie timbers, which is an important advantage in holding a frame in line transversely to offset weak sills or bad loading, and more particularly the latter.

CENTER OF GRAVITY OF LOCOMOTIVES.—SIMPLE METHOD OF DETERMINING.

By G. R. Henderson,

Assistant Superintendent of Motive Power C. & N. W. Ry.

The determination of the center of gravity of locomotives is a laborious task when computed mathematically, because in order to be accurate the weight and location of the center of gravity of each and every piece should be ascertained and their moments above the rail figured out, but the labor being so great, assumptions are made which affect more or less the final figures. It occurred to the writer that a practical method could be applied and the following was therefore evolved:

Suppose that we have a body of symmetrical cross section, the weight of which is known. If this body be tipped slightly so that one of the edges upon which it stands is lower than the other, the center of gravity will be displaced laterally. If this body rests upon supports at the two lower edges only, then the lower support will sustain more weight than the higher one, due to the lateral displacement of the center of gravity,

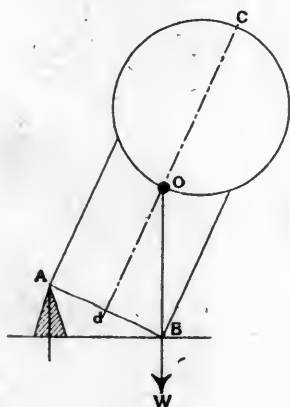


Fig. 1.

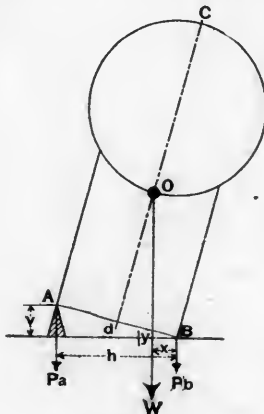


Fig. 2.

and if the angle is such that the center of gravity be vertically over the lower edge, the total weight will come on this edge, and the body will be in unstable equilibrium. Thus, in Fig. 1, the whole weight will come upon the support B, but in Fig. 2 a portion will rest upon A and another portion upon B, but the sum of these two will be equal to the total weight. Let the weight of a symmetrical body be represented by W, the load on each support by Pa and Pb, respectively; then Pa plus Pb

equals W. Let also the horizontal distance between the supports be represented by h and the vertical difference by v; also the distance measured horizontally between the support, B, and a vertical dropped through the center of gravity be represented by x. Now, by equal moments Pa × h equals W X, and X equals

$$\frac{Pa \cdot h}{W}.$$

As the body is symmetrical, the center of gravity must be in the central axis c-d and at the intersection with the vertical through y, at a distance X from B, or at O. This may be laid off graphically or it may be calculated by similar triangles.

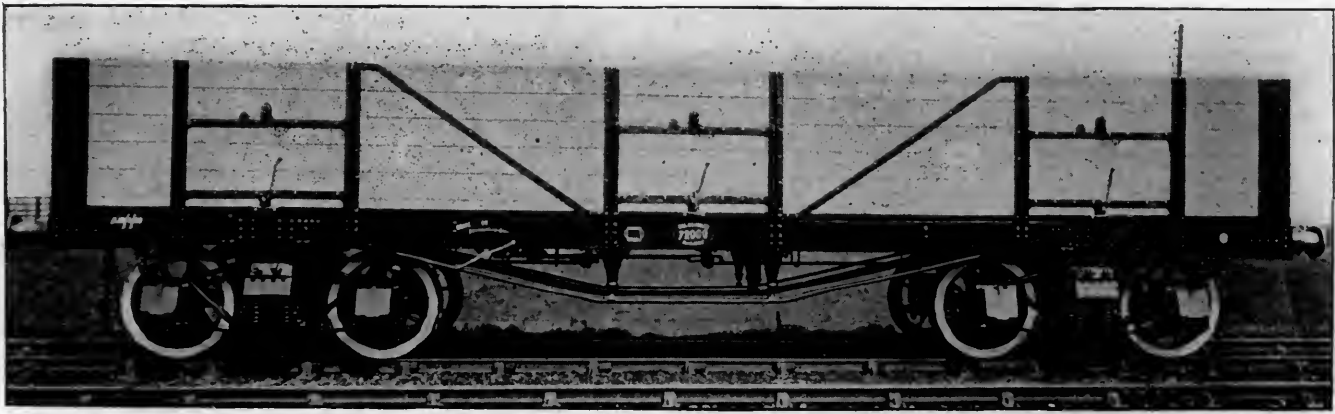
The reproduced photograph, Fig. 3, illustrates the application of this principle to locomotives. The engine was first carefully weighed on the track scales, with a certain height of water, etc., and was backed off the scales. The rail was then removed from the narrow side of the scale platform, and blocks laid close together, like ties from the outer frame to the fixed or dead rail support, care being taken to see that the portion of the scale under these blocks was entirely free. A rail was laid to gauge on these blocks, and a slope prepared at one end. All was now ready, and the beam being balanced, the water was brought to the same level as before in the boiler, and the engine run upon the new track, and the load upon the lower



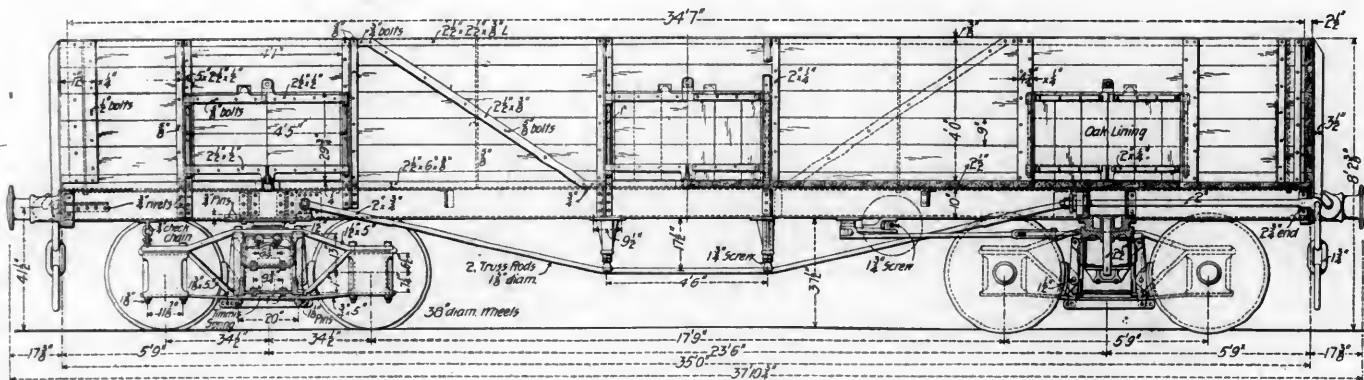
Fig. 3.—Easy Way to Locate the Height of the Center of Gravity of a Locomotive.

rail weighed. While the engine is upon the scales, a level should be run from rail to rail to determine the exact difference of level for use in making the calculations; in the case illustrated this was about $7\frac{1}{2}$ inches. Of course, there is a slight error, due to shifting of the water sidewise in the boiler, which tends to exaggerate the result. The frames should be blocked over the boxes, so that the boiler will stand relatively to the wheels the same as on level track.

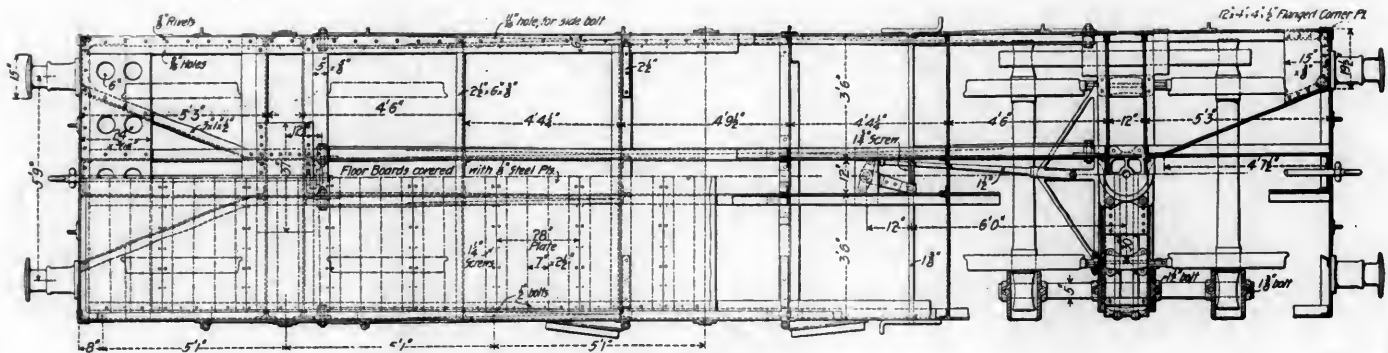
If care be taken, accurate results may be obtained, as with the small elevation mentioned, an increase in weight of 25,000 pounds on the lower side of the engine was shown by the scales, the total weight of the locomotive being about 140,000 pounds.



112,000-Pound Steel Ore Car—Caledonian Railway.
MR. JOHN F. MCINTOSH, Locomotive Superintendent.



Longitudinal Sections.



Plan and Section.

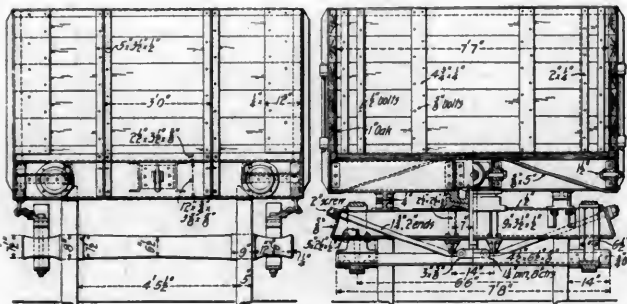
112,000-POUND STEEL ORE CARS IN SCOTLAND.

Caledonian Railway.

A departure in car construction in English practice is marked by the introduction of 50-ton (English tons of 2,240 lbs.) gondola cars of the American type upon the Caledonian Railway. Through the courtesy of Mr. John F. McIntosh, Locomotive Superintendent of the road, we have received a photograph of one of these cars, together with particulars and drawings.

These cars have steel underframes and wooden sides built on framing of steel and they are mounted on two four-wheel trucks, of the American type, with arch bar side frames. The design is by Mr. McIntosh, and the cars were built at the St. Rollox Works of the road.

The cars have four sills, which are 10 in. channels with plate end sills and frequent transverse stiffening plates, which, together with the corner braces, are clearly shown in the engravings. There are eight truss rods of 1 1/2 in. iron terminating at



End View and Transverse Section.

the bolsters and placed close together at each side of the longitudinal sills. The body bolsters are 10 in. channels and the truck bolsters are of the same section, 9 in. high and trussed with two $1\frac{3}{4}$ in. rods.

The journals are concave and 6 and $7\frac{1}{2}$ by 12 inches in size. We are not told the weight beyond the fact that they have only half the tare of ordinary English "wagons," although accommodating seven times the load of iron ore which the small ones will carry. Twenty of these cars take the cargo of a vessel carrying 1,000 tons of ore, and English traffic men are greatly interested in the experiment which promises great acceleration in the despatch and economy of handling such cargoes. The principal dimensions are as follows:

Capacity.....	50 tons iron ore
Total wheel base.....	29 feet 3 inches
Wheel base of truck.....	5 feet 9 inches
Length over headstocks	35 feet
Length over buffers.....	38 feet 4 inches
Length inside body.....	34 feet 7 inches
Width inside body.....	7 feet 7 inches
Depth of body.....	4 feet
Journals (concave).....	12 inches by 6 and $7\frac{1}{2}$ inches

Mr. McIntosh says that were it not for the narrow limits of clearance he would build the cars from 18 inches to two feet wider, and he would also make them higher. He also writes

Wheel base, engine.....	16 ft. 9 in.
Wheel base, total engine and tender.....	38 ft. $7\frac{1}{2}$ in.
Tractive force.....	17,800 lbs.
Tank capacity	3,080 gal.
Weight of engine.....	102,370 lbs.
Weight of tender.....	84,900 lbs.
Total weight of engine and tender.....	187,260 lbs.
Fuel space for $\frac{1}{2}$ tons of coal.....	

It is evident that Mr. McIntosh deserves a great deal of credit for the boldness with which he has treated the car design, and it is the more merited because he builds large cars without the advantage of the transition which characterized the movement in this country.

TEN-WHEEL FREIGHT LOCOMOTIVES.

Chicago Great Western Railway.

This road has ten locomotives like the one shown in the accompanying engraving, built by the Baldwin Locomotive Works, five of which are simple and the other five are Vauclain compounds. These engines have been running since last spring, and, while they are all giving good results, the compounds appear to show an advantage in fuel economy, but the



Ten-Wheel Freight Locomotive—Chicago Great Western Railway.
Built by the Baldwin Locomotive Works.

that this design is not confined to the ore traffic, but is also carrying grain, cement and steel billets. It is likely to be used in hauling coal for the locomotives of the road. The couplings are of the ordinary British type, and judging from experience with heavy cars in this country, it may be expected that they will need to be modified perhaps on the lines of our practice. The cars have Westinghouse brakes. They are also fitted with a simple device for applying the hand brakes from either side of the car, which was recently brought out by Mr. McIntosh. It is stated that the use of these cars in general service will necessitate many alterations along the line in the sidings and turntables, and that these changes will be made if the experiment proves to be successful. To us there is no doubt of the success of the car itself, the only question being as to the possibility of getting them over English roads with their restricted clearances. If successful in this regard, this experiment will probably lead to the introduction of large freight cars, carried on trucks, with automatic couplers and continuous brakes to replace the 8 and 10-ton cars of the present equipment. The innovation is interesting in view of the success of the large car in the United States.

A new design of 6-coupled freight locomotives has been brought out simultaneously with these cars, and specially intended to haul them. These locomotives, also built by the road at St. Rollox, are considered in Great Britain as specially powerful, particularly in boiler capacity. Their chief dimensions are as follows:

Cylinders	$18\frac{1}{2}$ in. dia. x 26 in. stroke
Wheels.....	5 ft. 0 in. dia.
Heating surface.....	1,440 sq. ft.
Working pressure	100 lbs. per sq. in.

length of service has not been sufficient to permit of determining exactly what the saving will be. We have received the photograph and information from Mr. David Van Alstine, Master Mechanic of the road. The engines have driving axles of "Coffin Toughened Steel," McIntosh blow-off cocks, Westinghouse air brakes, Tower couplers and Leach sanders. The principal dimensions are given in the following table:

Total weight of engine	160,000 lbs.
Weight on drivers	120,000 lbs.
Driving wheel base	15 ft.
Total wheel base of engine	27 ft. 2 in.
Diameter of cylinders, simples	20 in.
Diameter of cylinders, compounds	$15\frac{1}{2}$ in. and 26 in.
Stroke of piston	28 in.
Diameter of driving wheels	63 in.
Material of driving wheel centers.....	Cast steel
Flange tires on all driving wheels.....	
Driving box material	Cast steel
Diameter and length of driving axle journals.....	9 in. by 12 in.
Diameter and length of main crank pin journals.....	$6\frac{3}{4}$ in. by 6 in.
Engine truck, swing bolster.....	
Engine truck journals.....	6 in. by 12 in.
Engine truck wheels	30 in.
Boiler, style	Wagon top
Diameter at first ring	64 in.
Working pressure	200 lbs.
Firebox	112 in. by 42 in.
Number of tubes	275
Diameter of tubes	$2\frac{1}{4}$ in.
Length of tubes	15 ft.
Heating surface, firebox	130 sq. ft.
Flues	2,410 sq. ft.
Total	2,600 sq. ft.
Grate area	32.6 sq. ft.
Brick arch, supported on 3 in. tubes.....	

Tender.

Tender wheels	33 in. cast iron
Journals	$4\frac{1}{2}$ in. by 8 in.
Wheel base	15 ft. 4 in.
Tender frame	10 in. steel channel
Water capacity	6,000 gal.
Coal capacity	10 tons
Trucks furnished by Standard Car Truck Company.....	

COKE AS LOCOMOTIVE FUEL.

Boston & Maine Railroad.

The Boston & Maine has taken up the subject of coke as a fuel for locomotives in a systematic, practical way, and now has 100 locomotives fitted up for burning it exclusively. The favorable qualities of coke for this service have been known for a long time and its use is not by any means new, but we believe that it has never been adopted so extensively and so successfully before. Not the least interesting feature of the practice is the fact that the coke is obtained at a point far removed from the coal regions.

The introduction of the practice on the Boston & Maine was due to the interest which the president, Mr. Lucius Tuttle, takes in the subject of fuel, and its complete success is due to careful application and experiment on the part of the officers of the motive power department. Mr. Tuttle states positively to us that coke burning is an unqualified success and is no longer in any essential feature an experiment. He regards the coke which he is using as an ideal locomotive fuel and engines are being equipped to burn it as fast as possible. The present supply is at the rate of 100,000 tons per year, which is equal to about one-fifth of the amount which would be required for all the locomotives now in service. They would all burn coke if the supply was sufficient. On this subject more will be said later. Mr. Tuttle regards the use of coke as the best solution of the smoke, cinder, dirt and spark problems, and in fire claims alone he expects to save \$100,000 a year. He was led into its use by his experience on the New York, New Haven & Hartford because of the rigid smoke nuisance laws of the City of New York. When he was vice-president of that road he experimented with coke and used the Connellsville product for firing a number of locomotives out of New York, the experience being entirely successful as regards the fuel, but the cost was prohibitive for regular road service. Three years ago it was decided that the Boston & Maine was ready to use coke extensively as soon as the question of cost could be satisfactorily disposed of, and this has been done by the co-operation of Mr. Henry M. Whitney and the New England Gas & Coke Co. This company's plant at Everett, Mass., was designed to make gas from Dominion coal and the coke is one of the by-products. If the coke was obtained from coal without regard to other products the cost would be prohibitive, but the plan of these works is such that it is furnished at a cost which is more favorable to the road than that of coal, and while no elaborate comparative tests have yet been made between the two fuels, there is good reason to believe that in evaporative efficiency coke has an advantage. The exact cost is not divulged, but it may be stated positively that it is no more expensive than coal.

About 12 locomotives in suburban service were fitted up for coke burning in April of this year, and at present it is used in this service out of Boston, in switching service on nearly all of the important divisions and in some of the heaviest passenger service of the road between Boston and Portland. In every case it has been entirely successful, whether in short or long runs, and while used chiefly on passenger locomotives there is every reason to expect equally good results in freight work. Sixty of the engines on the Eastern and Western Divisions use it exclusively and the other 40 coke-burning engines are distributed over the other divisions. Its chief advantages are cleanliness and freedom from smoke and from spark throwing. In operation on the road there is a noticeable pale blue haze to be seen from the stack when the engine is working hard with the lever "in the corner," but after shortening the cut-off it is not to be seen except in tunnels or under bridges. The front ends are almost entirely clear but the nettings are not removed because of the possibility of drawing small pieces of fuel through the tubes when working hard. Some clinker forms, but not as much as is found with Dominion coal burned without coking, and most of the coke

clinker must be combustible, because it is very seldom necessary to remove it from the fireboxes even after a run of over 100 miles. It is easier to handle than coal, but its bulk is to that of coal as 5 to 3, and large racks are placed on the tenders of engines making long runs. It is the cleanest of solid locomotive fuels. A representative of this journal enjoyed a clean and comfortable ride of about 60 miles on one of these engines. There was no dust or dirt in the cab and none from the stack except a very fine whitish metallic dust which did not adhere to clothing and was not sufficient to be in the least disagreeable. It is evident that the running gear, valve motion and driving boxes will be greatly benefited by the absence of flying dust and grit from the coal. Mr. Tuttle has good reasons for considering it an ideal locomotive fuel.

At first it was considered necessary to use water grates because of the extremely high temperature of the fire which resulted in burning out ordinary cast-iron grates. The grates used in the earlier experiments had water bars like those for burning anthracite, and while these did not prove troublesome in any way it was considered desirable to avoid the troubles which time would be likely to develop by the burning out of the tubes. It was considered desirable to save the expense of fitting up the water grates and also to provide means for using exactly the same grates for coke as for coal. Experiment developed the fact that coke may be burned on ordinary cast-iron grates by introducing steam into the ash pans. This cools the grates and prevents them from melting by the intense heat; it also tends to reduce the amount of clinker. The present practice is to place a T in the exhaust pipe from the Westinghouse air brake pump and conduct a portion of the exhaust into a $\frac{3}{4}$ -inch pipe which extends down and across the front end of the ash pan. The end of the pipe is plugged and the steam issues from five $\frac{1}{4}$ -inch holes in this pipe and passes back under the grates. This steam does not appear to have any noticeable effect on the fire, but it is possible that it aids combustion as well as saves the grates. The engines are now converted into coke burners by the addition of this very simple piping and the use of a portion of this steam that would otherwise be thrown away. For the return to coal burning this pipe may be plugged or it may be provided with a cock. A part of the air pump exhaust is sufficient for the coke and only that portion is required that will naturally pass out of a pipe fitted up in this way, while the remainder goes up the stack. The water grates, steam jet piping and the cast-iron grates used in connection with coke are illustrated by these engravings. The cast-iron grate is not new, but is shown because it is successful in burning coke.

The evaporative performance is not yet known, but the regular performance sheets show a uniformly better record for coke than for coal, ton for ton. The advantage in severe passenger service is about one mile per ton. The records of this road are not given in ton-mile units. A part of the saving is in the reduction of back pressure which is due to the possibility of opening out the nozzles. Mr. Henry Bartlett, Superintendent of Motive Power, says that the nozzles of nearly all of the coke burning engines are made about $\frac{1}{4}$ inch larger than when using coal. This is a very important item because it affects the power of the engine as well as the fuel performance, and if the records were made on a tonnage basis this ought to make a still more favorable showing for coke. When working hard there is some movement of light stuff in the fire but it does not get to the tubes and the tubes are not seriously coated. The coating is easily scraped off at the end of a run and the tubes do not require cleaning out as often as with coal.

In steaming qualities very little if anything is left to be desired. Coke gives a remarkably hot fire and, thus far, there has been no indication of trouble with tube sheets or tubes. The fact that the fire door is not required to be wide open about half the time should favor these parts and herein is another advantage of coke. The practice is to fill up the firebox to within 3 inches of the door opening, working the

ovens, of which the New England Gas & Coke Co. has 150 in operation. The immense 288-acre plant of this concern in Everett, Mass., near Boston, will ultimately include 1,200 ovens and 400 are now ready for heating when the necessary provisions for using the gas are completed. This process reduces the cost of gas to such a point as to make it profitable for the gas companies of Boston to discontinue manufacturing, and mains are now under construction connecting the Everett works with the gas holders of the Boston gas concerns, who will become retail dealers of this by-product gas. The usual method of making coke is in "bee-hive" ovens, from which the gas is allowed to escape into the atmosphere. The Otto-Hoffman oven permits of saving not only the gas, but also tar and ammonia, and the coke is stated by the manufacturers to be in some respects superior to that from the bee-hive ovens. It is stated to be chemically equivalent to Connells-ville coke and at the same time is denser and physically stronger and also is superior in available heat units by about 4 to 8 per cent. It contains very little iron and sulphur. The slack ($\frac{1}{2}$ -inch size) of the Dominion coal is used for coking, the lump coal being otherwise disposed of. All these items and particularly the labor-saving appliances which have been worked out minutely at these works, also the great size of the plant, contribute toward reducing the cost of the coke.

The demand for coke in industrial establishments is likely to increase and the New England railroads may not for some time be able to secure as much as they desire. One road has already contracted to take 400,000 tons per year, when that amount is available, and other roads are experimenting with it for their own information, with a view of taking it up after the manner of the Boston & Maine. Inquiries are now being made as to the result, and we shall probably have further information on this subject.

Coke requires care in storage to protect it from the weather, because of its spongy character, and its tendency to absorb water. It should be stored in sheds. Much more information might be included in this description, but further space will be taken only to give the composition of this coke, which is as follows: Volatile matter, 1.27%; fixed carbon and sulphur, 69.82%; ash, 8.91%; moisture, 3.67%. These proportions, of course, vary with the coal.

A REMARKABLE PASSENGER RUN ON THE NEW YORK CENTRAL.

One of the new Schenectady ten-wheel passenger locomotives on the New York Central, illustrated and described in our issue of August, 1899, page 255, hauled an exceedingly heavy train over this road from New York to Albany on August 19th, which is believed to eclipse the records of previous heavy passenger trains. The train consisted of 16 cars, and, excluding the engine, passengers and baggage, weighed 707 tons. Its total length was 1,202 feet. The total weight of the 16 cars, empty, was 1,415,895 pounds. The weight of the mail (estimated) was 30,000 pounds, the baggage 15,000 pounds, the express matter 16,000 pounds, and the estimated weight of 600 passengers is 90,000 pounds, giving a total of 1,837,795 pounds, or 918 tons of 2,000 pounds, including the engine. The individual weight of the cars are as follows: First mail car, 82,775 pounds; second mail car, 87,250 pounds; coach, 86,160 pounds; coach, 93,100 pounds; smoking car, 46,700 pounds; coach, 64,360 pounds; coach, 64,850 pounds; cafe car, 100,000 pounds; dining car, 102,000 pounds; sleeper, 98,600 pounds; sleeper, 102,000 pounds; parlor car, 100,800 pounds; sleeper, 104,500 pounds; sleeper, 103,800 pounds; parlor car, 79,000 pounds; parlor car, 100,000 pounds.

The train made better than schedule time from New York to Albany, 143 miles. The schedule is three hours and fifteen minutes, including two stops, the required speed being 44 miles per hour. The running time of this train was three hours and thirteen minutes, including the two stops, which

made a speed for the trip of a little less than 44½ miles an hour. The total weight of the engine and tender is 270,900 pounds. The weight on drivers is 128,900 pounds and on the truck 40,000 pounds.

COMBINED PNEUMATIC BLOW-OFF COCK AND BOILER CHECK.

Wm. McIntosh,

Superintendent of Motive Power, Central R. R. of New Jersey.

A new combination of boiler check valve and a blow-off cock, which really assembles four functions in one device, has been designed and patented by Mr. Wm. McIntosh, Superintendent of Motive Power of the Central Railroad of New Jersey, the device and its attachment to the boiler of a locomotive being illustrated by the accompanying engraving. This arrangement embodies two check valves and a blow-off cock in one fitting, which is also used in connection with conduits inside the boiler, whereby water blown off may be drawn from the surface or from the bottom of the boiler, as desired.

The device combining the check valve and the blow-off cock is attached to the boiler in the usual way by means of a flange secured to the shell of the boiler by rivets. Into this flange the casing containing the valves is screwed and the check valve nearest the boiler is almost entirely within the flange itself, the only projection beyond the face of the flange being the end of the spindle where it passes through its guide. The attachment of the valve casing to the flange is reinforced by an annular extension of the flange into which the cylindrical portion of the casing fits, forming a substantial reinforcement to guard against the breakage of the casing at this point. The casing also contains an outer check valve, a blow-off cock and an air cylinder for the operation of the blow-off cock. The neck of the casing immediately below the blow-off cock is thinned down to make this point weaker than any other part, for the purpose of inviting fracture, due to any outside injury, at a point away from the main check valve, as a measure of safety.

The construction of the device is very clearly indicated in the engraving. The valves are guided and are not dependent upon wings to keep them in position. The check valves have wings arranged with spiral inclinations for the purpose of twirling the valves while in use, which tends to keep them free from obstruction. These wings are located at a sufficient distance from the face of the valve to give a full opening for the entrance of the water.

The blow-off cock requires little explanation, except to state that it is operated from the cab by air pressure, which is applied against the piston in the cylinder, the valve being brought to its seat by the spiral spring when there is no pressure upon the boiler. The purpose of the handle at the top of the valve is to provide means for opening and closing the blow-off cock by hand and its operation is made clear by the drawing. The air piston opens the blow-off valve and by pressing against the spindle of the inner check valve the boiler water is allowed to pass out.

The second engraving shows the method of attachment to the boiler. The two combination valves are applied to their flanges, and they open into flattened 4-inch tubes bent to conform to the shape of the boiler shell. The tube at the left is short and closed at the top. It deposits the feed at the bottom of the boiler and when blowing off takes the water from the same place. The other tube opens above the check into a pair of skimmers and the bottom end is fitted with a hinged valve. This tube deposits feed water at the bottom of the boiler and takes surface water when used in blowing off.

This little device offers several advantages over present practice, and in its service on a number of engines on the worst water district of the Chicago & Northwestern it has more than

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EDITORIAL ANNOUNCEMENTS.

Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street. London, Eng., Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.

The facts in the case of the introduction of Westinghouse brakes into Russia on a large scale have been published in this journal, and we now have a copy of the order issued by the Minister of Ways and Communication which was transmitted by Consul-General Holloway of St. Petersburg. The order states explicitly that this brake is to be applied to the locomotives and freight cars of the system of 5-foot gauge railroads of Russia, including both the government and private lines, the Transcaucasian Railroad and the roads in European Russia. The private lines may order the brakes directly from the manufacturers or they may secure them through the official channels; contracts made by the roads, however, must come before the Minister of Ways and Communication. It is made plain enough that the whole question of brakes is being handled officially. Provisions are made for careful instruction of train and engine men by the use of air brake instruction cars, and the order throughout gives the impression that the Russian railroad authorities do not intend to leave anything undone to insure satisfactory braking appliances.

Train resistance formulae have formed one of the most elusive subjects of investigation connected with the operation of railroads, and a great deal of excellent scientific work has been done in this direction, some of which dates back to 1829. Clark's formula has been proven over and over again to give incorrect results when applied to present conditions, and as the investigations go on the resistance of trains seems to diminish, as every new formula seems to indicate that previous ones were too high. Some of the formulae are as follows:

$$D. K. Clarke R = 8 + \frac{V^2}{171}$$

$$Engineering News R = \frac{V}{4} + 2$$

$$Baldwin Locomotive Works R = \frac{V}{6} + 3$$

$$P. H. Dudley R = 1 + V \div 8$$

The last mentioned formula is printed in a recent issue of the "Railroad Gazette," and was obtained from a large number of indicator cards taken at different speeds on a heavy freight engine hauling a heavy train on the New York Central between West Albany and De Witt. Each investigator gets up a new formula, and Mr. Dudley believes it necessary to use different constants for varying conditions of tracks and train weights. It may and probably will be necessary to use a great many constants, because those who know most about this subject believe that train resistance varies with every journal box. The more this subject is pursued the clearer becomes the fact that one exceedingly important factor is usually neglected. This is the acceleration or retardation of trains. There is no way to secure reliable data on train resistance which does not include these items, and it seems probable that one reason for the diversity of opinions arises from the variation of speed, which is the most difficult factor of all to provide for in the calculations.

The relative merits of the locomotive testing plant and road tests for securing reliable information in testing locomotives form an interesting and fruitful topic for discussion. It was introduced at the September meeting of the New York Railroad Club by Mr. R. P. C. Sanderson in a paper describing an elaborate series of road tests involving compound locomotives and valves of the piston and ordinary balanced types. There are advantages in both methods of testing and a careful estimate of the possibilities of both must lead to the conclusion that each has advantages not possessed by the other. Some will not see any good in road tests, because the uncontrollable conditions make it impossible to know what the results mean. Others will not have testing plant tests because the locomotive when run on rollers does not act as it does on the road. As road tests are usually conducted, under a species of excitement and with the interests, either professional or pecuniary, of certain individuals at stake and a view of securing data in the shortest possible time, the conditions are generally such as to render the results of very little value, because of the very great influence of the "personal equation." The fireman may, and usually does, influence the results of road tests more than any ordinary change the value of which is sought for in the tests. We have enough data at hand at this time to establish this statement. The conditions are likely to vary to such an extent with hurried road tests that there is no telling what the figures really indicate, and conclusions based upon them may generally be suspected. This is rather hard on road tests, but it does not mean that the idea of road tests is all wrong. It means that they should be extended over a length of time sufficient to overcome the influence of variables, and the effects of the prejudices of the men handling the engines, whether these are favorable or unfavorable. Variables may be controlled to a great extent in laboratory tests and the testing plant should unquestionably be used for work requiring the separation of factors, for example, in the comparison of different forms of arrange-

ments of exhaust nozzles and draft appliances. In such work the boiler conditions must be uniform and the speed must be controllable. It was possible to accomplish this in the tests of the Master Mechanics' Association committee on exhaust appliances in 1896 by the use of oil fuel on the testing plant whereby the conditions of boiler operation were kept constant and the speed was controlled by a centrifugal governor. It is obvious that road tests on such subjects would be valueless. The final settlement of many important questions must be had on the road, but those in which a slight change in one of several conditions which are constantly changing on the road will effect the results, should be submitted to the testing plant. Both the stationary testing plant and the dynamometer car are necessary, and each fulfills conditions that the other does not. Generally both will be needed in solving a problem in locomotive operation.

HIGH PRESSURE AND DRY STEAM.

The most favorable steam pressures for locomotives seem by many to be considered as settled at about present limits, and in recent discussions involving this subject it is made apparent that considerable comfort is being taken from this supposed fact.

It is generally believed that simple locomotives should not carry pressure higher than 190 lbs., and that 200 lbs. is most favorable for compounds. It has never been clearly demonstrated that either of these limits are correct, and the problem of pressures is unquestionably important enough to warrant specially careful investigation, in view of the great advances in economy which have been made in this direction in marine practice.

It is generally understood that higher pressures permit of improvement in economy at the engines and that this is the cause of the greatest improvement of modern steam engineering. It is not so well understood, however, that a great advantage may be gained by increasing the boiler pressure without increasing the pressure of the engines, and yet this is probably one of the most effective of recent improvements in marine work which has accompanied the rise of pressures in the engines.

By this is meant that there is a great deal to be gained by carrying a very high boiler pressure, which is reduced to a proper working pressure at the engines. The worst enemy of fuel economy is wet steam, and this reduction of pressure, which is accomplished without doing work, is an effective and inexpensive method of drying the steam before it goes to the cylinders. If the steam is dry when it leaves the boiler, it will be superheated by this process, and every one knows the desirability of superheating. The explanation for the superheating effect is simply that when steam passes through a throttled passage in a pipe and reduces its pressure, its pressure changes without a corresponding change in temperature, and it is therefore hotter after throttling than the pressure of the steam calls for in the tables of the properties of saturated steam. This excess temperature may disappear by evaporating moisture in the steam, drying the steam, or it may remain and the steam pass on into the engines in a superheated condition. This is advantageous because the cylinder is a powerful refrigerator and the entering steam needs all the heat it can carry, in order to remain dry as long as possible.

The British Admiralty believe that pressures in marine work will go higher yet. Pressures of 250 pounds and more are successfully used in marine engines, and when steam is furnished by Belleville boilers it is at a pressure of 300 pounds, this reduction at the engines being for the purpose of securing dry steam, as explained.

Dry steam will do more work than wet steam, and the locomotive is noted for using wet steam. The question raised here is whether there is not enough advantage to be had from dry steam at the cylinders to more than offset the additional

weight that would be required in the boiler in order to carry the higher pressures. This is one way to attain an increase in boiler capacity which is generally desirable, and the effect on the economy of working may be very easily ascertained. All that is necessary is the building of one locomotive boiler for a working pressure of say 250 pounds and a reducing valve in the steam pipe, to throttle the pressure to a proper working point at the cylinders. It would cost so little to investigate the merits of this question as to cause surprise that some enterprising motive power officer does not take it under consideration. We would like to emphasize what has in effect been already said: That this idea may possibly prove to be a good method for increasing boiler capacities.

COKE BURNING ON LOCOMOTIVES.

Coke as locomotive fuel is given considerable space in another column in this issue because of the important and new conditions which have arisen in New England whereby this fuel has already taken an important place in the operation of the railroads of that section. The new development of the manufacture of gas and coke from Dominion coal and the introduction of the byproduct coke oven render a good quality of coke available in considerable quantities, and the introduction of cheaper gas is likely to still further extend the employment of both coke and gas. In the new plant of the New England Gas & Coke Company the by-product and labor saving ideas are so well carried out as to raise the question whether coke or gas is the real by-product. This is chiefly a matter of price, but there seems to be good reason to believe that coke enough will be produced to supply the passenger and probably many of the freight locomotives of the New England roads when the facilities at present in sight are fully developed. It has so far been demonstrated that this coke may be burned successfully on locomotives without expensive preparations of the grates or fireboxes and that this fuel has several important advantages over coal. It is also, speaking conservatively, no more expensive than coal at the present prices, and, weight for weight, it seems to be fully equivalent to the coals most favorable for use in that section of the country.

If sufficient boiler capacity is provided there seems to be no difficulty in burning coke in either stationary or locomotive practice, but there appear to be some peculiarities in the burning of this fuel which render it advisable that the proportions of fireboxes and the provision of air openings should be most favorable to the fuel. Probably about two-thirds as much coke as coal may be burned per square foot of grate area per hour and the openings through the grates for the admission of air need to be somewhat larger for coke. This view seems to be supported by the fact that on the Boston & Maine it is found desirable to run with the fire door open on the latches. Coke consists chiefly of carbon and it is stated that while coal requires from 18 to 20 pounds of air, coke requires about 28 pounds per pound of fuel. The most favorable part of the heating surface for coke appears to be that of the fire-box, and if the promised large development of the coke producing industry is attained it will be important to ascertain the relative values of the different parts of the heating surfaces, such as the tubes and the firebox because of the effect of this knowledge on the design of locomotive boilers in which this fuel is used.

In looking up the subject of coke burning on locomotives all available information has been secured and it all points in one direction. It is a good fuel and its use depends upon the price and the supply. It has been used for some years on the Baltimore & Ohio and is now in use on the Fitchburg and the Boston & Albany, the reports all being favorable. It is not to be expected that coke will be generally used throughout the United States because it will be impossible to secure enough of it. It is probable, however, that what has been done in Boston will be done elsewhere.

PERSONALS.

Mr. E. B. Ashley has been appointed Chief Engineer of the Lehigh Valley.

Mr. J. B. Laurie has been appointed Purchasing Agent of the Central Vermont, to succeed Mr. W. B. Hatch.

Mr. Samuel Potts has been appointed Master Mechanic of the Los Angeles & Redondo, to succeed Mr. W. N. Best.

Mr. P. H. Irwin has been appointed Assistant Chief Engineer of the Baltimore & Ohio, with headquarters at Baltimore.

Mr. J. M. Ward has been appointed Master Mechanic of the Galveston, Houston & Northern, with headquarters at Houston, Tex.

Mr. J. E. Capps, foreman of Car Repairs of the Georgia Southern & Florida, has been given the title of Master Car Builder.

Mr. L. B. Rhodes, Foreman of Machine Shops of the Georgia Southern & Florida, has been given the title of Master Mechanic.

Mr. C. M. St. Clair has been appointed Master Mechanic of the Chattanooga Southern, to succeed Mr. H. T. Ellison, resigned.

Mr. R. L. Stewart has been appointed Master Mechanic of the El Paso & Northeastern, with headquarters at Alamogordo, New Mexico.

Mr. A. Sherwood has been appointed Master Mechanic at Wellington on the Santa Fe. He has been Round House Foreman at that point.

Mr. S. M. Felton has been elected President of the Chicago & Alton, to succeed Mr. E. H. Harriman, who becomes Chairman of the Executive Committee.

Mr. A. G. Leonard has been appointed Purchasing Agent of the Chicago Junction Railway, with office in Chicago, to succeed Mr. F. T. Croxon.

Mr. J. A. Danks has been appointed Master Mechanic of the St. Louis, Kennett & Southern, with office at Kennett, Mo., to succeed Mr. F. Glover.

Mr. John H. Kiesling has been appointed Master Mechanic of the Gulf, Beaumont & Kansas City, with headquarters at Beaumont, Tex., to succeed Mr. F. G. Papineau.

Mr. John Medway has resigned as Master Car Builder of the Swift Refrigerator Car Line. He was formerly Superintendent of Motive Power of the Fitchburg Railroad.

Mr. W. P. Dittoe has been appointed Purchasing Agent of the New York, Chicago & St. Louis, with office at Cleveland, to succeed Mr. M. M. Rodgers, who has resigned.

Mr. J. A. F. Aspinall, General Manager of the Lancashire & Yorkshire Railway, of England, is now in the United States studying the application of electricity to American railroads.

Mr. Lewis Greaven has been appointed Locomotive and Car Superintendent of the Inter-oceanic Railway of Mexico, with headquarters at Puebla, Mexico, to succeed Mr. H. E. Walker, resigned.

Mr. W. H. Reilly has resigned as Master Mechanic of the Fort Worth & Rio Grande, and Mr. C. H. Burk has been appointed Acting Master Mechanic, with headquarters at Fort Worth, Tex.

Mr. A. C. Hone has been appointed Superintendent of Motive Power and Rolling Stock of the Evansville & Terre Haute, to succeed the late John Torrence. Mr. Hone was Assistant to the Chief Engineer.

Mr. L. B. Heers has been appointed Master Mechanic of the new Pittsburg, Shawmut & Northern Railroad Company, with office at Angelica, N. Y. He has hitherto been Master Mechanic of the Central New York & Western.

Mr. Thomas Burns, Foreman of Locomotive Repairs of the Chicago, St. Paul, Minneapolis & Omaha, at East Saint Paul, Minn., has been appointed Assistant Master Mechanic of that road at Sioux City, Ia., to succeed Mr. J. K. Brassill, resigned.

Mr. W. J. Miller has resigned as Master Mechanic of the Kansas City, Pittsburg & Gulf, at Shreveport, La., to accept the position of Foreman of the shops of the St. Louis Southwestern, at Pine Bluff, Ark., to succeed Mr. Oliver Galbraith, resigned.

Mr. John Hair, Master Mechanic of the Ohio Division of the Baltimore & Ohio Southwestern, at Chillicothe, O., has been appointed Master Mechanic of the Mississippi Division of the same road, with headquarters at Washington, Ind., to succeed Mr. C. E. Walker, resigned.

Mr. W. H. Harrison, formerly Superintendent of Motive Power of the Baltimore & Ohio Lines west of the Ohio River, died of heart failure September 9. He was 68 years old and had served the Baltimore & Ohio 45 years, ending last March, and was one of the best known and most highly respected motive power men in this country.

Mr. John T. Carroll has been appointed Mechanical Engineer of the New York, Chicago & St. Louis R. R., with office at Cleveland, to succeed Mr. Theo. H. Curtis, who recently resigned to take a similar position with the Erie. Mr. Carroll has been connected with the Brooks Locomotive Works for seven years, also with several railroads, among which are the "Rock Island" and the Chicago & Northwestern.

Mr. S. W. Simonds has been appointed general engine-house foreman of the New York Central, with headquarters at Mott Haven. He was formerly a locomotive engineer on the Boston & Maine, afterward general road foreman of engines on the Fitchburg, master mechanic of the last named road, and subsequently held a similar position on the Philadelphia & Reading. His appointment to his present position marks a new departure on the New York Central, of which we shall probably have more to say later.

Mr. Isaac H. Congdon, well known as the inventor of the Congdon brake shoe, and formerly Superintendent of Motive Power of the Union Pacific, died at his home in Omaha, August 21, at the age of 66 years. He was born in Massachusetts in 1833 and began railroad work in 1851 as a machinist on the Cleveland, Columbus & Cincinnati. Afterward he worked as a machinist on the Springfield, Hartford & New Haven, and in 1853 returned to the Cleveland, Columbus & Cincinnati as machine shop foreman. In 1860 he was made Master Mechanic of the Great Western Railway at Springfield, Ill., and in 1866 he went to the Union Pacific as General Master Mechanic. He served in that capacity for 16 years, when he received the title of Superintendent of Motive Power in charge of both the locomotive and car departments. He resigned this position in 1885.

CAR LIGHTING WITH PINTSCH GAS, CITY GAS AND ACETYLENE MIXTURE.

The idea of using cheap gas for car lighting or of mixing acetylene with Pintsch gas to increase its richness, has long been an attractive one to railroad officers, and in response to a request from a well-known superintendent of motive power for information as to the possibilities of reducing the cost of car illumination, we have looked into the subject with a view of presenting the reasons why city gas and mixtures of Pintsch gas and acetylene are not used in this country.

Thirty-nine years ago the Philadelphia & Reading Railroad began to equip railroad passenger cars for lighting by gas. They built compressors and used city gas drawn from the mains in Philadelphia. Afterward a coal gas plant equipped with compressing, storage and delivery apparatus was established at Reading. The latter plant was changed into an oil gas plant, and the advantages of the richer gas, both in the economy of producing the required amount of light per hour, and the multiplied hours' supply, carried in the tanks of the cars, was so apparent that the use of city gas at Philadelphia was discontinued and a Pintsch plant established. The operation of the plant at Reading was then modified to conform with Pintsch practice as regards quality of gas and degree of compression.

The gas now used averages six times the value of compressed city gas. The latter is not manufactured for compressing, and suffers a considerable loss in illuminating power when compressed. Various tests show this to be from 40 per cent. to 60 per cent., the kind of gas, system of manufacture and method of operation all affecting the net result.

One hundred and sixty-seven cu. ft. of Pintsch gas, the universal selling price of which is 85 cents throughout the United States, gives at least as much light as is given by 1,000 cu. ft. of city gas, and to the first cost of the latter must be added the expenses incidental to its compression and delivery to cars. This additional cost averages about \$1.25 per thousand cu. ft., making the net cost of 1,000 cu. ft. of city gas in cars about \$2.50. For a given amount of light, the less rich in illuminants the gas is, the more the cost of compressing enters into the cost of the light. Six times the cost of compressing must be included in the case of city gas, where the cost enters but once when Pintsch gas is used. Therefore the question arises, how rich a gas can be used and still further reduce this considerable element of cost?

The conditions of gas lighting on railroad cars are different from those generally met with in gas lighting, in this important respect: The entire apparatus is continually subject to jars and chatterings, which detach dust, scale, etc., from the inner surfaces of pipes, tanks and fixtures. The detached particles are carried along by the flow of gas, and if any passage too small for them is encountered, a stoppage occurs. The smallest passage is usually the orifice of the burner, and in the early days of Pintsch practice in the United States, it was necessary to use a tip of the union jet type, having two holes each 0.023 inch diameter. Afterward a change was made to a larger size with holes 0.029 inch and a great improvement was effected. To reduce the size of these orifices below what are now used would therefore be a step in the wrong direction, but this would be necessary if a richer gas were supplied than is now furnished from the Pintsch plants. The question therefore of using a richer gas is disposed of by this practical limitation, and the question of the method of making the richest gas that can be used is one of dollars and cents.

The Pintsch gas supplied in the United States gives from 10 to 12 candles per cu. ft., varying according to the degree of compression and the temperature, either an increase of the former or a decrease of the latter tends to cause a reduction in candle-power.

Acetylene mixed with Pintsch gas is used in Europe, and a great deal has been written on the subject. The practice there

is to form a mixture 20 per cent. of which is acetylene and 80 per cent. Pintsch gas. By the addition of this proportion of acetylene the illuminating power of the gas is increased over 100 per cent., but even when so enriched it gives but 8½ candles per foot, the Pintsch gas in Europe being inferior in quality to the product of the American Pintsch gas. Experiments have shown that a mixture of 5 per cent. of acetylene with Pintsch gas made from American oils will combine to make a gas which has a tendency to smoke, even when used in the small-sized Pintsch tips.

CASE HARDENING.*

The process of case hardening has not changed materially for the past few years. The principal materials used remain the same: Granulated rawbone, hydro-carbonated bone black, black oxide of magnesia, sal soda, charcoal and salt. These materials are commonly used in railroad shops and give much satisfaction if they are carefully and properly handled.

For pins and bushings, and such light work as is required for immediate use, we use the "New York Specialty case-hardening powder;" this we found to be greatly superior to pot-ash.

The work which is to be hardened can be packed in cast or wrought iron boxes, sealing with fire clay or mud, so as to prevent the gases from escaping as much as possible. The pieces to be hardened should be placed about two inches apart in the box. The vacant spaces are well filled and packed with the material you are using for case-hardening purposes. Should your box be supplied with heavy work, as crank pins, guides, etc., 15 to 20 hours of steady heat is necessary in order to secure best results. If, on the other hand, you have light pieces, as links, link blocks and pins, 8 to 10 hours will be sufficient to subject them to a good heat.

This class of work we place in the furnace about 8 o'clock in the morning and heat it all day. At night we close up the furnace, letting the box remain over night, and remove next morning. Reheat this work and cool in cold water. We have secured good results using granulated rawbone. If using hydro-carbonated bone black, pack the pieces in a box and seal as before.

Furnaces for case-hardening should be so constructed that the boxes will not have to be raised or lowered while being put into or taken from the furnace. The heating space is near the ground. The firebox and ashpan are below the surface. This refers to a furnace heated with soft coal. If the furnace is outside of a building, a stack or chimney, about 16 feet high, will furnish draft enough to heat the boxes without aid of a blast. Case-hardening furnaces which are heated with fuel oil are of a very different construction, the boxes being generally heated from the top; with coal, in most cases, it is from the bottom. The cooling tub is arranged so as to admit cold water from the end near the bottom, the cold stream thus running lengthwise along the bottom of the tub. This cold stream forces the hot water to flow over the top of the tub.

When cooling guides or long pieces, strips or bars of iron should be laid in the bottom of the tub, in order to keep the work about two or three inches from the bottom of the tub; in this way the cold stream flows under the work which is being cooled.

Soda ash as a preventive of troubles from bad boiler waters received strong praise before the Travelling Engineers' Association from an officer of the mechanical department of the Chicago & Northwestern Railway, who spoke particularly of the effect on the flues in preventing trouble which formerly caused them to leak. The number of flues welded in one shop had decreased from 22,376, in the year 1893, just before the use of soda ash was commenced, to 9,902 in 1898. During this time the mileage per engine had greatly increased.

*Paper read at the Convention of the National Railroad Master Blacksmiths' Association by Mr. John Buckley.

CORRESPONDENCE.

PORT OPENINGS OF LOCOMOTIVE VALVES.

Editor American Engineer:

In the June issue of the American Engineer, Mr. R. A. Smart contributed an article on the subject of this letter, and attributed the reduced area of one of the diagrams published therein to loss of port opening, due to distortion of the valve motion by the friction of the valve.

We must, of course, understand from this that he believes that the friction was greater when the smaller diagram was taken, although he offers no reason why this should be so, but says that the valve was properly and thoroughly lubricated, during the entire test, and also admits that no undue springing of the valve gear was noticeable.

Why should the size, or weight, or friction of the valve, if uniform, produce distortion of the valve motion at one time and not at another, and why should the greater size of the valve in the case mentioned, aside from its increased weight (an inadequate cause for such a result, anyway), add to the friction, if a relatively large area was balanced? If the speed had been higher, when the smaller diagram was taken, we should look for about the same initial pressure, as the increased inertia of the valve, due both to its weight and increased speed, would undoubtedly maintain the full port opening, but for a falling steam line due to the higher piston speed.

Variations in the extent of initial condensation, due to accumulation of water in the cylinders, or to fluctuating fires, falling evaporation, and consequent saturation of the steam, which experience shows, can take place, to some extent, without reduction of boiler pressure, are much more probable causes of such losses than those that Mr. Smart has assigned. A bad steaming engine will not maintain the highest effective pressures in the cylinders, even if the fireman does succeed in holding the full boiler pressure.

W. F. CLEVELAND.

Philadelphia, Pa.

FEED WATER HEATERS FOR LOCOMOTIVES.

Editor American Engineer:

In regard to the question of heating and purifying the feed water for locomotive boilers, discussed in the April issue of your paper, page 116, and in the January issue, it may be of interest to learn how the foreign engineers have handled this problem. Several attempts have been made on the continent during the last three or four decades to heat and purify the feed water by either live steam or that of the exhaust.

The first apparatus designed to accomplish this object was that of Kirchweyer, then appeared the injector by Mazza and the pump by Chiazzeri, which were fixed on the boiler of an Italian locomotive exhibited in 1878 during the exposition in Paris. This pump heated the feed water to a temperature of 176° to 192° Fahr. by the aid of the steam from the exhaust. After this followed the injectors by Koerting, Manlove, etc., the first of which was combined with a water heating apparatus, and which forced the feed water into the boiler at a temperature of about 190° Fahr.

These different injectors and pumps have been tried by several railroads on the Continent, but chiefly by the Paris-Orleans Railway; while they effected a considerable economy in the total steam consumption, their complicated mechanism, which necessarily required much attention, and the cost of keeping them in repair more than compensated their virtues. Another important drawback to their extensive application was that the exhaust steam, employed to raise the feed water to a certain higher temperature, allowed the oils with which it was impregnated to pass into the boiler.

To overcome this difficulty in using the exhaust steam for heating the feed water Mr. Lencauchez, engineer of the Paris-Orleans Railway, has designed a heater combined with an oil separator so that before the exhaust steam comes into contact with the cold water from the tender it has already been separated from its greasy elements. This form of heater is in actual service on twenty freight locomotives of the above-named road, and which is shown in Figs. 1 and 2.

The exhaust steam, taken from each cylinder by two separated pipe branches, arrives through the pipe, J, into the oil separator, I, passes the toothed end of pipe, J, as seen in

Fig. 2, and strikes the bottom, B B, of the oil separator, I; from here, in order to penetrate into the upper portion of the cylinder, I, it has to pass through a very fine grating, K K, composed of a number of scooped-out plates and assembled in such a manner that the steam has to make several up and down courses during which it leaves the oil it contains on the hollowed-out portions of the grating, K K. The steam thus purified passes through, u, into the annular space, Z Z, and thence through the openings, t t, into the heater proper, where it comes in contact with the cold water.

This cold water is forced into the heater by a pump through the pipe, a, passes through the jet, b, and falls, fountain-like, on the upper vase, d. From here the water tumbles in cascades on the lower discs or vases, d', d'', d''', and passing over its finely toothed edges, it is divided into very small streamlets which facilitates, makes more thorough and rapid the mixture of the cold water with the steam, which, as above stated, arrives through the orifices, t t. The heated water then fills the bottom reservoir, f, from which by the aid of a hot water pump it is forced into the boiler at a temperature of 192° to 203° Fahr.

It will be seen from Fig. 2 that the orifice, N, is provided with a check valve, O, which the steam opens when it passes into the heater; should the hot water pump fail to work, the excessive supply of cold water in the heater will immediately shut off the communication with the cylinders and thus prevent any water from passing therein; at the same time it will also raise the safety valve, c, as shown in Figs. 1 and 2, and which is loaded to a pressure of 7 lbs. to the square inch, and empty its over-supply through it. The greasy residue, accumulated in the bottom portion, B B, of the oil separator, I, is discharged into the ash pan by opening cock, l, by piping leading thereto; the end of the pipe in the pan is so bent as to prevent any air from passing into the cylinder, I. The heater is also provided with a water gage, as shown in Fig. 1.

The boilers fed by this kind of heater are also provided with injectors which serve when any one of the pumps fails to work.

Another form of heater and water purifier has been lately designed by Mr. Chapsal, engineer of the Western Railway, of France, and adopted on some locomotives on that road. The heater, which is shown in Figs. 3, 4 and 5, is in the form of a dome with internal cones and is located on the boiler. In designing this form of heater and water purifier, Mr. Chapsal desired to realize the following conditions:

1st. The cold water from the tender, on its arrival into the heater, should be subjected to a great reduction of its velocity in order to facilitate the formation of scale to be deposited on the cones.

2d. If the feed water be intermittent, the volume of the heater should be large enough to hold all the water forced in by each single feed in order to utilize the interval of time of two successive feeds in heating the quantity of water of the previous feed.

If, however, the feed be a continuous one, the capacity of the heater should be such that the duration of the passage of the cold feed water over the several cones should be long enough to permit the precipitation of the limestone contained in the water; it will be seen, therefore, that the heating surface of these cones has to be large enough to raise the water rapidly to a temperature at which limestone deposits are formed.

3d. The decomposition, by the heat, of the bicarbonates which form very thin layers of carbonate of lime, should be deposited on very thin plates in order that by their contraction at each feed of cold water the layers of scale just formed may be broken and slid down in the annular space of the heater.

In referring to Fig. 3 it will be seen that the cold feed water from the tender is brought into the heater by two tubes, T, passes over a series of cones, in which steam circulates, and is being heated by virtue of the contact with them. As the arrow lines indicate, the water passes through the holes of the single cones of large diameter and then over the contour of the double cones of a smaller diameter; thus heated to a certain degree, it forms deposits on the thin surfaces of the cones, which, when broken by the contraction of the latter, is accumulated around the bottom edges of the large cones, whose generatrices are made much more inclined than those of the small double cones. The water then passes through a coke filter (which on later designs of the heater has been dispensed with) in the upper portion of the dome and through the tube, T', into the boiler.

This heater was applied to an express locomotive of the

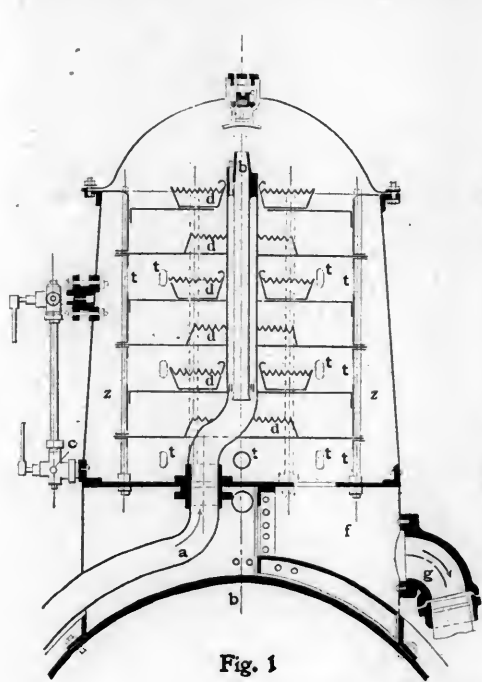


Fig. 1

Feed Water Heater for Locomotives.
Paris-Orleans Railway, France.

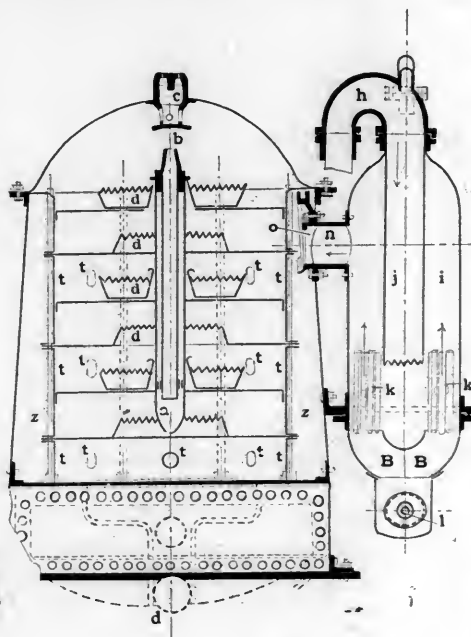


Fig. 2

Havre line in May, 1890, and it was found that the deposits of laminated tartar, when weighed in a dry state, varied from 22 to 44 lbs. for a running distance of 1,875 to 3,750 miles.

In conclusion I will mention one of the attempts to use electricity as a preventive from boiler incrustation; this is the "electrogene" of d'Hannly which was frequently tried by different railroad companies on the Continent, but with discouraging results (though the English Admiralty speaks well of it). It is composed simply of a ball of zinc weighing about 40 lbs. suspended in the water space of the boiler by a copper wire from the flues or rivets from firebox. According to the inventor, the zinc and boiler form a galvanic battery, hydrogen deposits on the surface of the plates and prevents the adhesion of the water sediments thereon the deposits are, therefore, easily removed from the boiler by washing out.

If the above will offer some suggestions to those engaged in the solution of the feed water heating problem, I shall be very satisfied in gathering the above information. CHAS. M. MUCHNICK.

Fives-Lille, France, August 30, 1892.

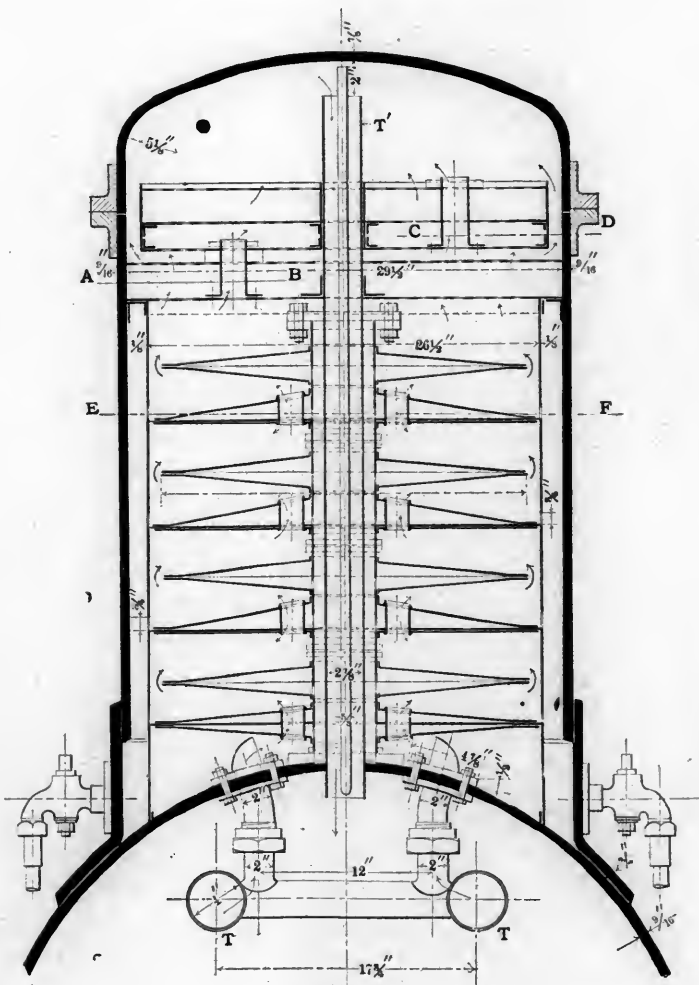


Fig. 3

Feed Water Heater for Locomotives.
Western Railway of France.

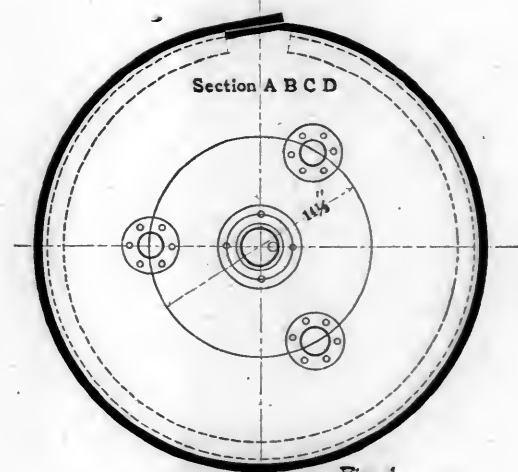


Fig. 4

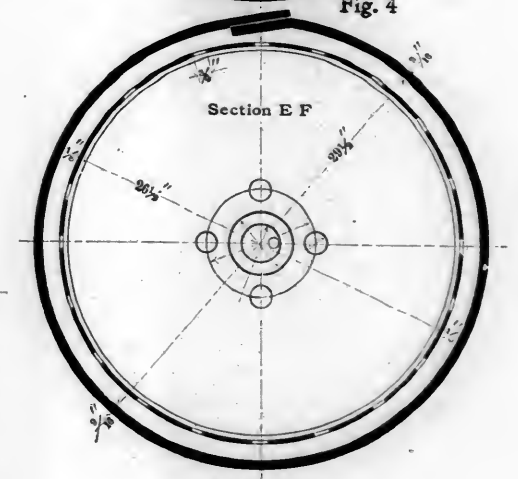


Fig. 5

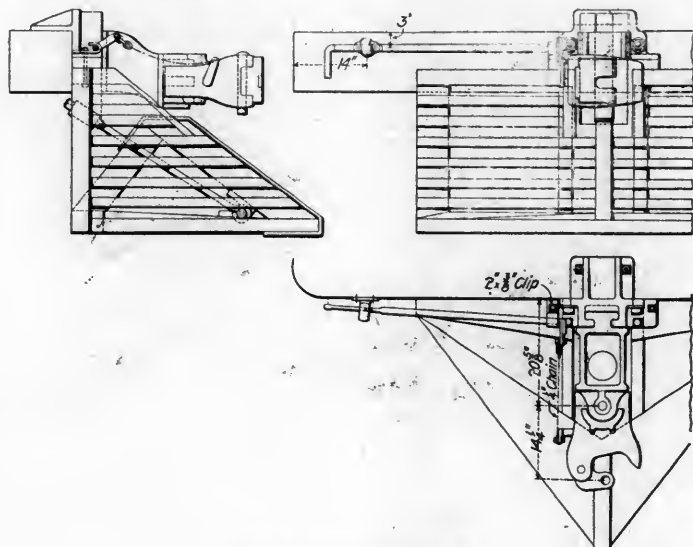
"To strengthen the legal remedies for the protection of such patents as may be issued after a thorough examination."

These worthy objects are in the hands of officers some of whom are well known. The President is Mr. Francis H. Richards of New York. Mr. T. N. Ely of the Pennsylvania Railroad is one of the Vice-Presidents. Among the members of the executive council are Messrs. C. E. Billings, of Hartford; Dr. R. J. Gatling, of New York, and A. A. Pope, of Boston. A meeting of the association is proposed for October of this year. The office of Mr. F. H. Richards, President, is 9 Murray St., New York.

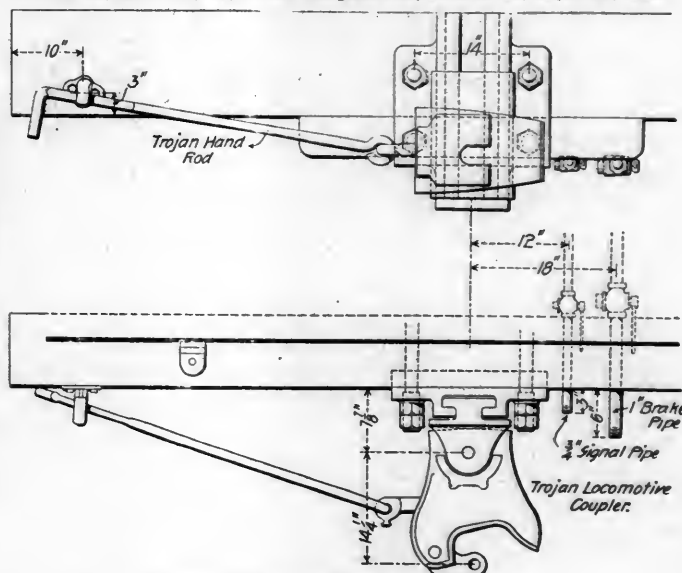
LOCOMOTIVE PILOT AND TENDER COUPLER.

Atchison, Topeka & Santa Fe Railway.

An arrangement of locomotive couplers for pilots and tenders has been devised on the Atchison, Topeka & Santa Fe Railway for the purpose of providing a swing motion to the coupler itself and permitting of vertical adjustment of the coupler without necessitating changes in the attachments which are permanently secured to the pilots and to the rear of



Locomotive Pilot Coupler.



Locomotive Tender Coupler.

Atchison, Topeka & Santa Fe Railway.

the tenders. The plan illustrated employs the same coupler head for both ends of the engine, the head being pivoted so that it will swing through a limited arc either way from the center line on curves, and this pivot is carried in a steel casting, the inner end of which is shaped to fit in a vertical socket, which forms part of the casting attached to the pilot or to the tender. In the case of the pilot socket this casting is made in the form of a bracket, as indicated in the drawing. The bottom of the socket in the supporting casting is closed and the coupler may be varied in height by placing a wooden block of the proper thickness in the socket, the lowest position of the coupler being attained by omitting the block altogether. This arrangement renders it very easy to adjust the height of the coupler, which is done without the use of any tools. The attachment is also easy to replace in case repairs are needed. The parts are all made of cast steel, and from the drawing it is apparent that an adjustment of about six inches in height is provided. This arrangement is being applied to all new engines on the Santa Fe lines and it is also substituted in repairs of old engines. Referring to the drawing, it will be seen that the pilot is arranged to clear brake beams, the pilot being 48 inches long.

RAILWAY ACCIDENTS IN 1898.

According to the advance report of the Interstate Commerce Commission, the total number of casualties to persons on account of railway accidents during the year ending June 30, 1898, was 47,741. The aggregate number of persons killed as a result of railway accidents during the year was 6,859, and the number injured was 40,882. Of railway employees, 1,958 were killed and 31,761 were injured during the year covered by this report. With respect to the three general classes of employees, these casualties were divided as follows: Trainmen, 1,141 killed, 15,645 injured; switchmen, flagmen and watchmen, 242 killed, 2,677 injured; other employees, 575 killed, 13,439 injured. The casualties to employees resulting from coupling and uncoupling cars were persons killed, 279; injured, 6,988. The corresponding figures for the preceding year were, killed, 214; injured, 6,283.

The casualties from coupling and uncoupling cars are assigned as follows: Trainmen, killed, 182, injured, 5,290; switchmen, flagmen and watchmen, killed, 90, injured, 1,486; other employees, killed, 7, injured, 212. The casualties resulting from falling from trains and engines are assigned as follows: Trainmen, killed, 356, injured, 2,979; switchmen, flagmen and watchmen, killed, 50, injured, 359; other employees, killed, 67, injured, 521. The casualties to the same three groups of employees caused by collisions and derailments were as follows: Trainmen, killed, 262, injured, 1,367; switchmen, flagmen and watchmen, killed, 13, injured, 69; other employees, killed, 38, injured, 367.

The number of passengers killed during the year was 221 and the number injured was 2,945. Corresponding figures for the previous year were 222 killed and 2,795 injured. In consequence of collisions and derailments 72 passengers were killed and 1,134 passengers were injured during the year embraced by this report. The total number of persons, other than employees and passengers, killed was 4,680; injured, 6,176. These figures include casualties to persons classed as trespassers, of whom 4,063 were killed and 4,749 were injured. The summaries containing the ratio of casualties show that 1 out of every 447 employees was killed and 1 out of every 28 employees was injured. With reference to trainmen—including the term enginemen, firemen, conductors and other trainmen—it is shown that 1 was killed for every 150 employed and 1 was injured for every 11 employed. One passenger was killed for every 2,267,270 carried and 1 injured for every 170,141 carried. Ratios based upon the number of miles traveled, however, show that 60,542,670 passenger-miles were accomplished for each passenger killed and 4,543,270 passenger-miles accomplished for each passenger injured.

For protective coatings for iron and steel the Master Car and Locomotive Painters' Association, in their recent convention, expressed preferences for oxide of iron, graphite and carbon pigment. Pure graphite was considered excellent, but this paint was liable to be adulterated with silica, which, while being a good filler, did not give good wearing qualities.

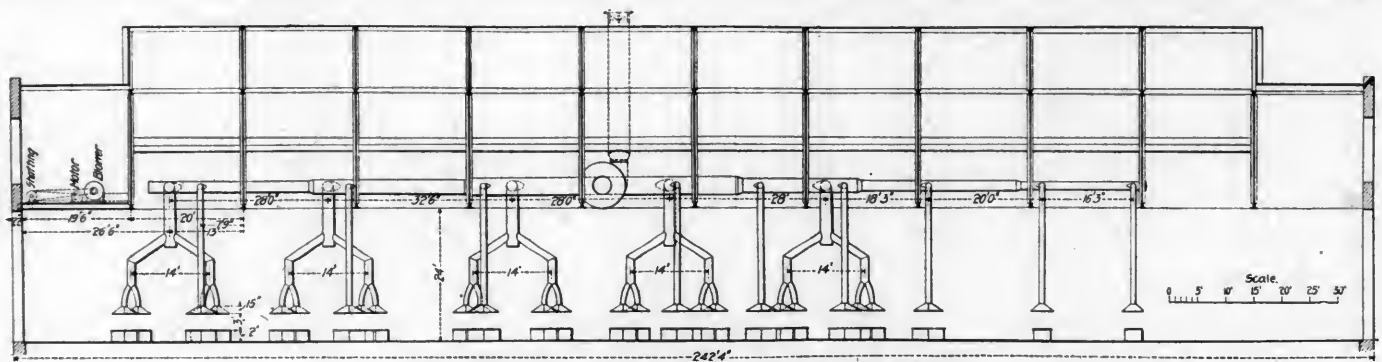


Fig. 1.—Longitudinal Section of Blacksmiths' Shop.
Westinghouse Electric and Manufacturing Co.

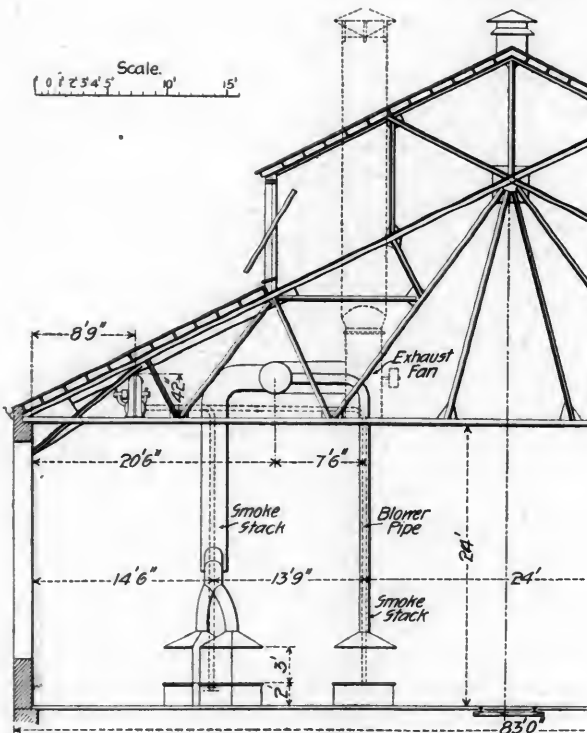


Fig. 2.—Cross-Section of Blacksmiths' Shop.

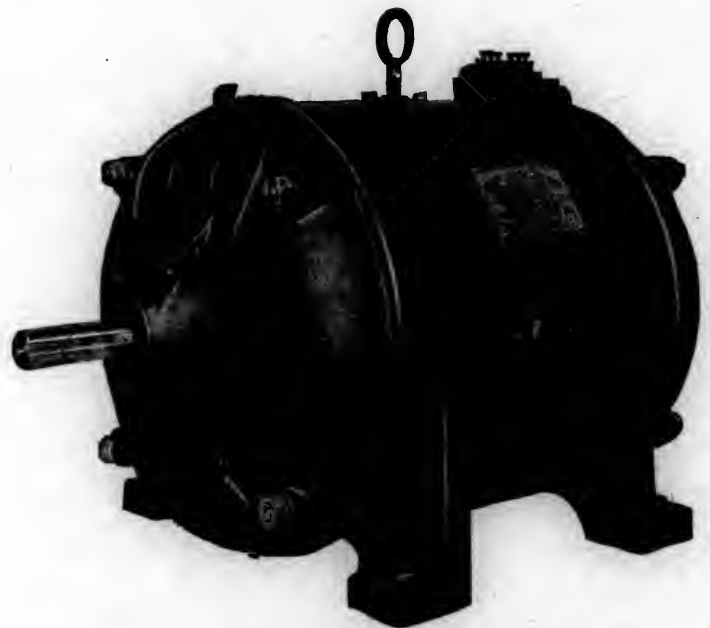


Fig. 4.—Westinghouse Direct-Current Dust Proof Motor.



Fig. 3.—Westinghouse Type "C" Induction Motor.

ELECTRIC POWER IN BLACKSMITHS' SHOPS.

In response to a request for a description of a modern blacksmith shop with improved methods of transmitting power, the following article has been prepared with a view of illustrating good methods for application to railroad shops.

The blacksmiths' shop attached to the works of the Westinghouse Electric & Manufacturing Company is operated electrically. It has been so ever since it was erected in 1894. The first consideration in a large smithy is the disposition of the smoke from the forges, and a supply of forced draught for the fires. In the Westinghouse shops these two operations are provided for in a very simple manner. There are two rows of forges on each side of the shops. To provide forced draught a blower driven by a small electric motor is erected to take care of the forges on each side. The blowers and motors are placed in a gallery 24 feet above the floor. These blowers force air through pipes carried horizontally above each line of forges. Connected with this horizontal pipe, vertical pipes 3½ inches in diameter carry the forced draught under the fires of the forges. The amount of draught is regulated by a hand lever at each forge. In order to remove the smoke a hood about four feet square is erected over each forge, three feet above the fire. This hood narrows upward into a six-inch pipe. Four of these pipes are led into a larger vertical pipe, which joins a

horizontal flue leading to the smokestacks. A smokestack is provided for each side of the smithy, in which operate fans, driven by electric motors. By this means there is a continual updraft from each forge, which draws in and carries off the smoke from the fires. The effectiveness of this method is shown by the bright color of the paint upon the roof, which is to-day clean and bright, in spite of the fact that it has not been repainted since the shop was erected in 1894. A longitudinal section of the blacksmiths' shop is shown in Fig. 1, and a cross-section in Fig. 2.

Electricity is also utilized to drive various special tools. An electric motor is placed in the gallery, 24 feet above the floor, which is belted to a line of shafting, to which in turn the tools to be operated are belted. The bulldozer, for bending plates and bars, is one of the special tools operated by electric power. Shears of different sizes are also worked electrically.

In the blacksmiths' shops of the Westinghouse Electric & Manufacturing Co. the hammers are operated by steam, as that power was available, but compressed air may be used. Nearly every railway repair shop, and other large shops, are equipped with air compressors, which serve to operate hammers as successfully as if steam were used. In many works air compressors are driven by electric motors. Electric driving is recognized as standard practice in operating modern blacksmiths' and machine shops. It offers greater flexibility and facilities than can be obtained by any other system. Several railroad companies have put in electrical equipments.

The Atchison, Topeka & Santa Fe Railroad have equipped their Ft. Madison shops, Iowa, with apparatus of the Westinghouse Electric & Manufacturing Company, and have installed generators and motors which operate machines and tools, either by direct connection or by belting to a continuous line of shafting, driven by motors. The electrical current is also used for the railway yards, operating turn-tables for locomotives. The Pennsylvania Company have equipped their Fort Wayne, Indiana, repair shops with electricity. The Westinghouse Electric & Manufacturing Company have installed two 100-kilowatt generators and a number of Westinghouse type "C" motors for operating planing, cutting, punching and other tools. In some cases a type "C" motor is mounted upon a truck on wheels, which can be shifted from one machine to another as required.

The electrical engineer of the Washington Navy Yard has recently fitted up an entire machine shop with shafting worked with Westinghouse electric motors. The building is 250 feet long, the shafting runs the whole length of each side of the building raised 20 feet above the floor. Upon each side the shafting is divided into two sections, an electric motor being bolted to one end of each section, and a fly wheel fixed to the other end to secure better regulation. The two sections may be coupled together in case of need and driven by one motor. The machine tools are belted to pulleys upon the line of shafting. This is a very simple and convenient arrangement for providing power, and occupies no floor space. The Continental Iron Works, Brooklyn, N. Y., have an extensive electrical equipment, and use Westinghouse motors largely in their shops. This firm has a world-wide reputation as the builders of the "Monitor." The Westinghouse type "C" motor is practically automatic, and requires a minimum of attention. See Fig. 3. The revolving parts are enclosed and there is no sparking, which makes it suitable for use in powder factories and wherever explosives and inflammable material is present. The Westinghouse direct current motor, shown in Fig. 4, is made in all sizes, and is adapted to all purposes where wheels have to be revolved or power is required. Both classes of Westinghouse motors are made in all sizes, from $\frac{1}{2}$ horse-power to 500 horse-power.

In our issues of February, March and April, 1898, the electrical distribution of power at the Concord shops of the Boston & Maine R. R. was illustrated. The operation of this plant has been entirely satisfactory and electric power is now being installed at other shops of this road.

THE NEW YORK CENTRAL ANNUAL REPORT, SHOWING THE ADVANTAGE OF INCREASING TRAIN LOADS.

The first report of the New York Central covering a year under the direction of President Callaway, has just been received and it fulfills the expectations of those who have anticipated material improvements in the economy of operation. The entire record is interesting, but we have space for only a few of the operating items. The gross earnings for the year for the system east of Buffalo were \$410,417 more than last year, or not quite 9/10 of one per cent. increase, but the net earnings increased 5 per cent. The freight tonnage increased $8\frac{1}{2}$ per cent. and the tonnage carried one mile was $3\frac{1}{2}$ per cent. greater than the previous year. While the rate per ton per mile decreased from 6.1 to 5.9 mills, the freight earnings per train mile were \$1.90, as compared with \$1.83 for the previous year, a gain of 3.8 per cent. The good showing is due to improvements in operation. The following paragraphs are reprinted from the report:

The decrease of \$382,032.63 in the year's expenses does not fully represent the extent of the economy in operation and maintenance. Notwithstanding the increase in the volume of business handled, the expense of conducting transportation decreased \$448,155.05.

The introduction of 28 new mogul locomotives ("American Engineer and Railroad Journal," November, 1898, page 362) each capable of hauling 80 loaded 30-ton grain cars (making a gross weight of 3,600 tons for the train and its load), has resulted in a saving of 505,114 train miles, or $3\frac{1}{2}$ per cent. decrease, although the volume of freight traffic was $8\frac{1}{2}$ per cent. greater. Twenty additional locomotives of the same type were ordered toward the close of the year.

The average train load for the entire system, including company freight, was 346 tons, as against 320 tons in 1897-8. The average is, of course, much reduced by the large proportion of the mileage of branch and leased lines on which the train load is necessarily small. On the New York Central main line the average train load of through freight, east and west, was 750 tons.

The increase in engine mileage was 372,303 miles, being less than 1 per cent. and little more than one-tenth of the increase of 1898 over 1897.

In handling the freight traffic for the year, 6,025,855 cars were engaged, a decrease of 28,905. The average number of freight cars in main line trains, through and local, east and west, was 49.

The cost of engine repairs per locomotive mile run was 3.47 cents. The cost of freight-car repairs, including \$908,550.35 of extraordinary items, was 14.15 cents per train mile. The cost of passenger car repairs per train mile run was 5.01 cents.

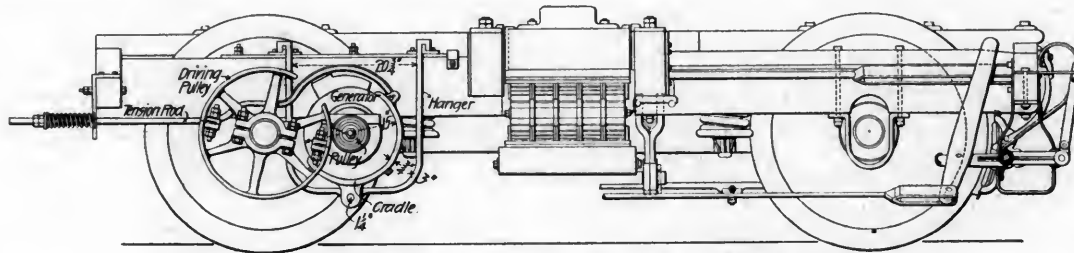
The cleaning of passenger cars received an unusual amount of attention at the recent convention of the Master Car and Locomotive Painters' Association in Philadelphia. Frequent cleaning under the direction of a practical painter was advocated because of the saving of paint and varnish and also because of the superiority of the work when done under intelligent and competent direction. Mr. T. J. Rodabaugh of the Pittsburgh, Ft. Wayne & Chicago, spoke very highly of Modoc Liquid Soap for cleaning the inside and outside of cars, stating that cars should not be cleaned with anything that would "kill" or mar the varnish. He did not believe in washing cars every day with water and a coarse brush, especially in warm weather, because if the weather is hot the lustre of the varnish will soon be killed and the car will look flat. He recommended cleaning cars, recently out of the shop, with liquid soap every 30 days, and they should be wiped off after every trip with carefully picked waste.

Mr. Frank J. Smith, Foreman of the shops of the Baltimore & Ohio Southwestern at Seymour, Ind., has been appointed Master Mechanic of the Ohio Division of that road, with headquarters at Chillicothe, O., to succeed Mr. John Hair, transferred.

AXLE LIGHTING.

Improvements in Generator Connection and Lubrication.

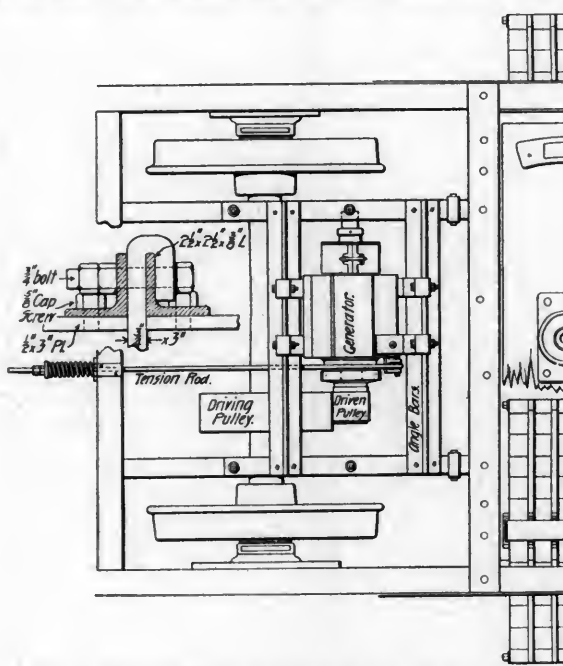
The system of lighting railroad cars by electric current generated from the axle, which has been developed by the National Electric Car Lighting Company of New York, has made use of a belt connecting the axle to the generator, and while it has proved to be possible to make this work satisfactorily when camel's-hair belts were used, the elimination of the uncertainty of the life of the belt was seen to be desirable, and this company has recently improved and simplified its apparatus by substituting direct frictional contact between a fibre roller on the end of the generator shaft and a pulley mounted



Truck with Generator for Axle Lighting—Atchison, Topeka & Santa Fe Ry.

on the axle. The belted connection required a countershaft between the pulley and the generator, the triangular connection of which, together with spring mountings in the countershaft bearings, provided for the vertical motion between the generator and the axle. The slack was adjusted by tightening the springs of the countershaft bearings. The average life of a belt with this arrangement was not above 15,000 miles, and the arrangement shown by the accompanying engravings insures a life of at least 35,000 miles for the transmitting pulley, which, we are told, is a statement based on experience.

The engravings illustrate the new method of mounting the generator and the construction of the fibre roller or pulley.

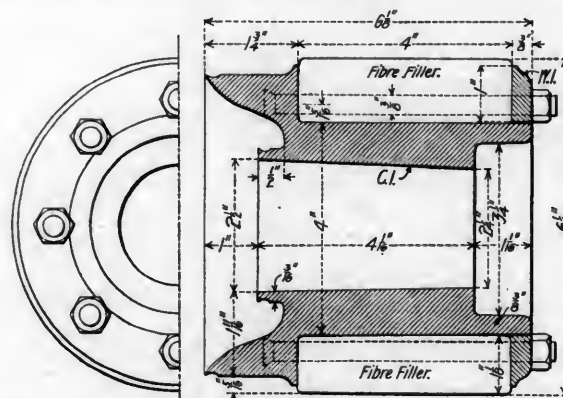


Plan of Truck Showing Generating Apparatus.

The generator is carried under the frame of the truck, to which it is hung in slings and carried on a hinged support at the bottom, as shown in the elevation. A tension rod urged toward the left by a spring draws the roller to the driving pulley with a pressure which is adjustable. It will be seen at a glance that the vertical motions of the generator with reference to the axle are fully provided for in a very simple manner.

In the detail drawing of the driven pulley or roller the method of substituting a new fibre filler for one which may have become worn is seen to be easy. It is stated that this improvement is giving excellent results on the Atchison, Topeka & Santa Fe, where it has been for some time in service. This road has this lighting system in use on about a hundred cars and it is understood that it is to be extended.

In addition to a material reduction in the number of parts the new arrangement renders the generator more accessible and the lubricating problem is greatly simplified. In connection with lubrication another improvement has been made, whereby the oil is carried in a tank containing about 2½ gallons, which is connected to the lubricating devices by a sight feed, and the valve regulating the supply of oil is controlled by a sole-



Driven Pulley—Showing Method of Holding the Fibre Filler.

tion of the axle light is to be pushed, and it is understood that the company is also experimenting with a system of car refrigeration, in which the power will be taken from the axles in the same way as it is now taken for electric lighting.

The use of the old Providence station in Boston for trains was discontinued on the morning of September 10, the trains having been transferred to the new South Union Station at that time. There are now but two passenger terminal stations in Boston, and the consolidation of the passenger traffic planned some time ago is now completed. All trains now leave from one of these stations, and the next improvement ought to be a satisfactory way for passing quickly from one of these terminals to the other.

CASKEY PORTABLE HYDRO-PNEUMATIC RIVETER.

The accompanying engraving shows a sectional view of : new form of portable riveter manufactured by Pedrick & Ayer, Philadelphia, Pa., especially intended for ship-yards and structural iron works, and the use of boilermakers and bridge-builders.

The Caskey Portable Hydro-Pneumatic Riveter is designed for using compressed air as a prime mover, with a hydro-carbon fluid used in the oil chambers and oil cylinders. This plan admits of the machine being operated in very cold weather and in open places with no liability of freezing and causing trouble as is sometimes the case with riveters of hydraulic operation, and this is urged as an important feature.

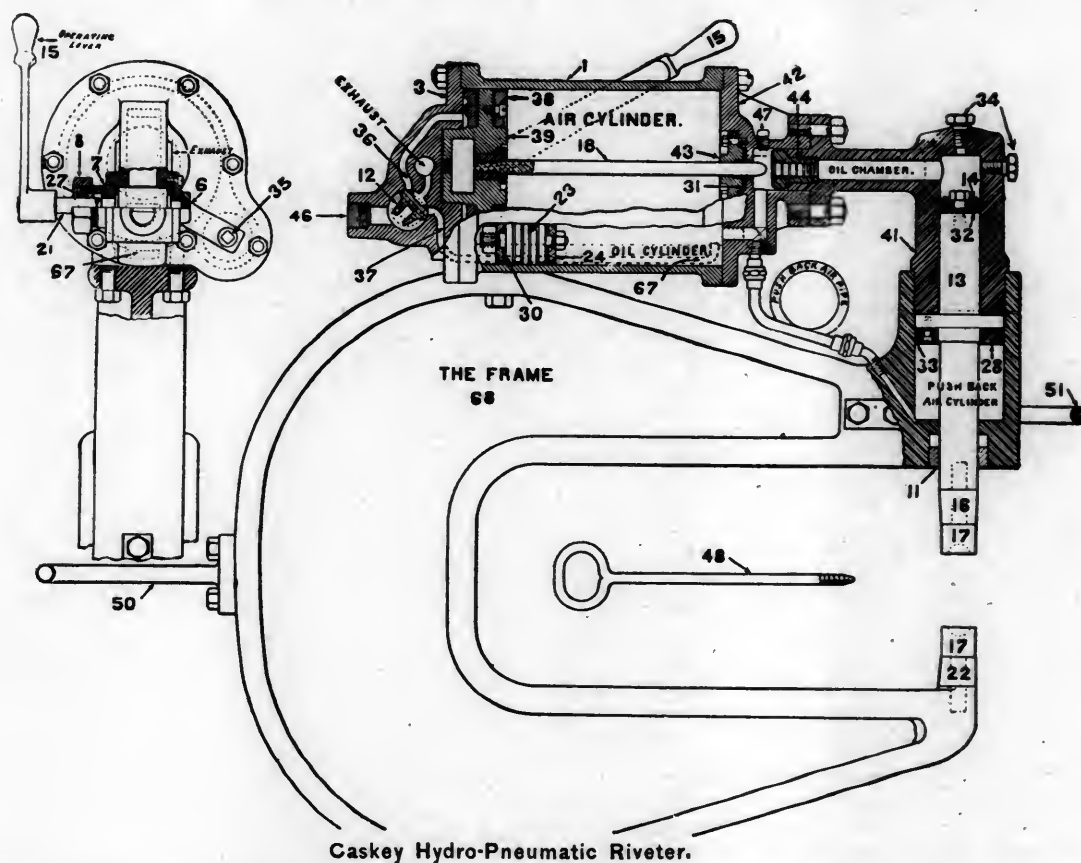
The engraving is largely self-explanatory. The main frame 68, is a steel casting, and may be made in any desired shape adapted to the conditions and positions in which the riveter is to work. The oil chamber and pressure cylinder, 41, is a nickel steel forging accurately machined. The dolly bar or hydraulic

tor may control all movements of the riveter whether standing at the side, back or front of the machine.

No adjustment of the length of the dolly bar, or the rivet dies, 17, is required when riveting on various thicknesses of metal. The dolly bar has a movement of $4\frac{1}{2}$ inches. The first $2\frac{1}{4}$ inches is known as the rapid movement, which is set down direct by the pressure of 80 pounds from the receiver tank. The last $2\frac{1}{4}$ inches is the effective movement and develops the maximum pressure, giving a uniform squeeze throughout the entire stroke of the last $2\frac{1}{4}$ inches, which causes the hot rivet in the hole to be upset, filling the hole.

The pressure is exerted on the dolly bar through the hydro-carbon fluid, which is non-freezing, and so long as the operation valve is open, admitting compressed air to the main piston, the maximum squeeze is maintained on the rivet.

After a rivet is headed, the dolly bar and the die are positively moved back from it by a quick movement of the operating lever. Every detail entering into the construction of the riveter has been studied to make it satisfactory. It is made of the finest quality of materials, with specially designed machine



Caskey Hydro-Pneumatic Riveter.

piston, 13, is of the best tool steel, accurately machined, hardened and ground. The inside cylinder head, 42, is of cast steel.

This machine is built for very hard usage, and is intended to avoid liability of breakage. There are but four moving parts, and the operating lever, 15, is the only moving part exposed. All packings are easy of examination. The construction of the machine was designed to secure the maximum pressure on a rivet with a minimum weight in the machine. It works rapidly, without shock or jar, is easy to handle and gives a uniform pressure on every rivet. No blow is given when using this machine, and therefore no injury is imposed upon the rivet when being driven.

The riveter is suspended by a bale which allows it to be moved and operated in either a vertical or horizontal position; by changing the bale it can be used sideways with equal facility. Suitable handles are provided on the front and back for the convenience of the operator in placing it over the work. The operating lever is so constructed and connected that the opera-

tools and thoroughly tested before leaving the shops of the manufacturer. It is built in twenty-one different styles and sizes, for driving rivets from $\frac{3}{8}$ inch to $1\frac{1}{4}$ inches. All machines are proportioned for using compressed air at 80 pounds per square inch, and to exert whatever pressure on rivets is required. Messrs. Manning, Maxwell & Moore, 85, 87, 89 Liberty Street, New York City, are the sole agents and will be pleased to send further information on application.

Wireless telegraphy operated under the personal direction of Signor Marconi will be used by the "New York Herald" for reporting the yacht races for the America's cup off Sandy Hook next month. Signor Marconi is on his way from Liverpool with four assistants. The instruments will be installed on board the Plant Line steamer "Grande Duchesse," and communication will be held between that vessel and a cable ship which will be anchored near the Scotland lightship, from which cables will be carried to the land lines.

WATER FOR HOT LOCOMOTIVE BEARINGS.

It has been generally believed that the practice of running cold water upon heated journals and crank pins of locomotives was injurious to the metal and a practice not to be permitted. A change of opinion is now indicated by the practice of some of the most important roads in providing means for cooling the journals of engines that are used in specially important service, and the opinions expressed before the Travelling Engineers' Association at the recent convention tended to show that less damage resulted by the use of water than would inevitably be caused by the failure to use it. It is, of course, not intended that water should be used except in cases of emergency, but when a heavy train is run on a fast schedule and hauled by a heavy locomotive it is exceedingly important to possess means for getting the train over the division in spite of hot journals. This is specially the case in fast mail service, which involves fines for delayed trains. It may be thought by some that hot journals indicate carelessness, defective judgment or neglect, but while any of these will cause them, there are other causes which it appears to be impossible to understand and prevent. It is for these that the piping of water from the tender should be provided.

In some cases the warm water from the injector is piped to the engine truck boxes, the driving boxes and crank pins, while in others provision is made to use cold water from the tender tank. It does not seem probable that there is any advantage in using warm water, whereas there is an important advantage in the use of cold water because of its greater absorption of heat. The important question is the temperature of the parts when the water is applied. The hotter the bearing the greater the danger of injury from sudden cooling, and this applies particularly to the brass. If the water is applied in time there seems to be no reason why it should not be used. The piping should be arranged in such a way as to permit of cooling a bearing or pin without stopping, and this applies to tender truck journals as well as the engine bearings.

It is important that the water should be applied at the right place. This, in a driving box, seems to be at the side of the bearing at the beginning of the arc of contact with the brass. The bearing creates a suction at this point, as was explained on page 91 of our issue of March, 1898, and the water is carried over the top of the journal, where it is most effective in absorbing the heat and conducting it away. The method of introducing the oil to the driving box illustrated in the article referred to, and also the one shown on page 183 of our issue of June, 1899, as employed on the Class H5 and H6 locomotives of the Pennsylvania Railroad, is believed to be a good one to reduce the liability of heating, and if it is advisable to introduce oil at the sides of journals it seems probable that this is equally true of water when the object is to flood the journal. On some roads the piping is arranged to take the water to the oil cellars. Good results have been obtained in this way.

In the report of the committee on this subject before the Travelling Engineers' Association, Prof. Goss is quoted as follows: "The use of water on bearings will not injure the bearings unless they are very hot before the water is applied; even then the damage should be attributed to the heating rather than to the use of water in cooling. If the water is applied when the bearing first begins to heat, and if used in sufficient quantities to prevent the melting of the babbitt, it is my opinion that no damage whatever results from its use. Whether the water is used hot or cold it is probably more a question of convenience than otherwise. I do not think that cold water is more severe in its effect upon the bearing than hot, and, other things being equal, a similar quantity of cold water would serve the purpose."

It was pointed out in the report that in marine service heavy bearings are often run for 30 days without lubricant of any kind except water, and no bad results were experienced. It is

safe enough to consult and follow marine practice in this matter and the best authority on the operation of marine engines says: "There is no great risk to be apprehended from the supply of water to a bearing which is only beginning to warm up, and the engineer should apply the water service and hose promptly to prevent the brasses heating. On the other hand, an overheated bearing must be treated with far more consideration; the sudden application of water in such a case may cause cracks due to unequal contraction."

One of the chief reasons for Mr. Andrew Carnegie's success is the ability to see that in order to be in the front rank of manufacturing it is necessary to make use of every labor-saving improvement. This involves discarding old machinery and replacing it with new, and often comparatively new machinery is superseded while practically as good as new. The "American Machinist" speaks of him as the "champion scrapper" because he retained no machine or method for what it had done, but considered only present or potential energy. Contrasted with this principle is the one of using a machine until absolutely worn out. A representative of this journal recently visited a railroad shop in company with the newly appointed superintendent of motive power of a road, who had become responsible for the shop where he had learned his trade thirty years before. The old lathe upon which he worked at that time was pointed out. It was still in service and taking up space that was greatly needed for a machine adequate for the demands of modern practice. Mr. Carnegie never hesitated to throw away a machine, as scrap, when he could fill its place with one that would pay for doing so by its increased efficiency.

The use of the Wells light for obtaining intense local heating for flanging the door holes of locomotive boilers was noted by Professor Hibbard in his paper on locomotive boilers, recently read before the New York Railroad Club. The flame is exceedingly hot and with portable apparatus the heating may be directed very conveniently. A somewhat similar use of this light is mentioned in the report of the City Engineer of Providence, R. I., for last year, in melting out the lead from the joints of old water mains in order to remove them from the trenches. With an air pressure of 25 pounds per square inch and the consumption of two gallons of oil, a joint in a 24-inch cast-iron main was melted out in about one hour.

BOOKS AND PAMPHLETS.

A Manual of Locomotive Engineering, With an Historical Introduction. By William Frank Pettigrew. London: Charles Griffin & Co., Limited. Philadelphia: J. B. Lippincott Company; 430 pp., 5½x8½ inches.

In taking up a new book a reader is apt first to refer to its preface, where he may expect to find a statement of the author's objects in writing it. In the preface of Mr. Pettigrew's book he says that "In it the locomotive engine is looked at chiefly from the point of view of the designer or locomotive draughtsman, and the scope and treatment have been mainly determined with reference to his needs; * * * and the calculations which it has been necessary to employ are accordingly suited, as far as possible, for every day use in the engineer's drawing office." He says further, "the work is largely based upon experience gained in the drawing office and workshops, under some of the leading locomotive engineers in this country, supplemented by information kindly furnished by the locomotive departments of the various railway companies."

This "scope and treatment" is obvious all through the book, and to describe it in a phrase it might be said that it is more descriptive than explanatory. What is meant by this observation will appear by quoting a definition of "description" and the word "explain." A "description," it is said in the dictionary, is "an enumeration of the essential qualities of a thing or species." To "explain" is "to make plain, manifest or intelligible; to clear of obscurity; to expound." All through the book the enumeration of the essential qualities of things described, predominate over what might be called their exposition, so that most of the chapters read more like specifications than dissertation in the philosophy of locomotive engines.

The general scope of the book will appear from the main

Headings of the chapters. These are: Historical Introduction, 1763-1863; Modern Locomotives, Simple; Modern Locomotives, Compound; Primary Considerations in Locomotive Design; Cylinders, Steam Chests and Stuffing Boxes; Pistons, Piston Rods, Crossheads and Slidebars; Connecting and Coupling Rods; Wheels and Axles, Axle Boxes, Horn Blocks and Bearing Springs; Balancing Valve Gear, Slide Valves and Valve Gear Details; Framing, Bogies and Axle Trucks, Radial Axle Boxes; Boilers; Smoke Boxes, Blast Pipes, Firebox Fittings; Boiler Mountings; Tenders; Railway Brakes; Lubrication; Consumption of Fuel, Evaporation and Engine Efficiency; American Locomotives; Continental Locomotives; Repairs, Running, Inspection and Renewals; Specifications; Principal Dimensions of Locomotives; Table of Modern British and Foreign Locomotives; Index.

The heart of a reviewer nearly always warms towards an author who gives his readers a good index. In this instance this requirement of critical form has been complied with. The index is copious and occupies 12 pages.

The book is elaborately illustrated and contains nine folded plates and 285 smaller engravings. These are generally good, although there are some "process" illustrations which are very shaky. Figs. 9 and 202 may be referred to as instances. The reduction in these and other cases has been too great, so that there is not body enough left to the lines. It may be wondered, too, that an author who has "gained his experience in a drawing office" would consent to allow an engraving like Fig. 143 to go into his book without having the sections hatched or cross-lined, which would have added so much to its clearness. These are, however, minor blemishes.

The book contains an immense amount of descriptive matter of the various subjects to which the chapters are devoted. It will be very useful, too, in that many leading dimensions are given which can so readily be referred to. The details described are, of course, nearly all English, as might be expected, but the American student will be very dull who will not avail himself of all the light which English practice will shed on the marvelous art of locomotive construction.

As an illustration of a foreign idea, which, so far as this critic is informed, is unknown, or at least unpracticed here, reference may be made to the rolling rubber packing ring used in vacuum brake cylinders, and described on page 267. The American reader will find all through the book descriptions of the way they do things in England which may not be as good, or may be better than what we do here, but which it will profit any one who is not a conceited mechanical ass to acquaint himself with.

In one respect, though, we should dissent from the author's arrangement of his book. Reference is made to the historical introduction which forms the first chapter. The history of an art is always studied last by a student of it. When a young man or young woman begins to learn to ride a bicycle they never preface their learning by a study of the history and development of that interesting vehicle, but they get, if they can, the latest pattern "wheel" and devote their study to that alone, and have little concern about its history. A boy when he first becomes interested in steam engines gets all the information he can about the latest and best example within his reach, and it is difficult to arouse any interest in him for the historical development of that wonderful mechanism. It has been said that interest in antiquity betokens the departure of youth; and in a measure it seems to mark a decline in the acquisitive faculties. To give a history of an art first, in a treatise on it, seems to be a reversal of the natural order in which we acquire knowledge, and for that reason the historical past ought always be relegated to the end of the book and not given in the beginning.

The book here reviewed is commended to the readers of the *American Engineer* and others, and every student of locomotive engineering should acquaint himself with its contents.

Universal Directory of Railway Officials, 1899. Compiled from Official Sources by S. Richardson Blundstone, Editor "The Railway Engineer." Subscription price five shillings. After publication, to non-subscribers, ten shillings. London, 1899: The Directory Publishing Co., 8 Catherine Street, Strand. Representative for the United States, E. A. Simmons, 697 Chauncey St., Brooklyn, N. Y.

This is the fifth annual volume of the valuable list of railroad officials, including roads in all parts of the world. It has been enlarged and now contains 56 pages more than last year.

The additions consist chiefly in light railways, and these are distributed over a number of countries. The directory section is enlarged by 33 pages and the personal index by a corresponding amount. The information is compiled from official sources and is probably as accurate as possible in the nature of the work. With the opening of further possibilities in the expansion of foreign trade in railroad supplies, the list, giving, as it does, the chief officers of the most important railroads of the world, with their addresses, will be very valuable to many manufacturers in this country as well as to the officers of railroads. In the list the length of each road and the amount of equipment are included. The finding list of officials and the information for each road are printed in type that is easily read. The advertisements, of which there are many, are placed by themselves at the end of the book, except a few which are placed at national divisions of the work. We find the directory of great value in our editorial office, and commend it to others.

Proceedings of the American Railway Master Mechanics' Association. Thirty-second Annual Convention, Held at Old Point Comfort, Va., June 19 to 21, 1899. Edited by the Secretary, Mr. J. W. Taylor.

This volume is uniform in size and binding with those of the past three years, and as these are in the possession of many of our readers, comment is unnecessary except to remark upon the surprising promptness of the appearance of the complete record of the convention, which was received only eleven weeks after the conclusion of the convention. We know of no other organization of this importance that is able to, or at least does, bring out its official record in such a short time. The deliberations of the association are recorded in condensed form by the technical press during the sessions, but this does not answer the purposes of those who desire to examine the unabridged record for the treatment of important subjects. The Secretary, Mr. J. W. Taylor, is entitled to a great deal of credit for this difficult performance and for the careful editing of the proceedings.

Bullock Electric Power System.—The Bullock Electric Manufacturing Company of Cincinnati, Ohio, have issued a pamphlet, Bulletin No. 2,428, illustrating and describing their method of operating newspaper presses, a large number of which in New York City and elsewhere are driven by their system with the "teaser" method of control. Newspaper press driving requires a most satisfactory power system, and the list of prominent daily papers and other well-known publications printed by aid of this system, as given in this pamphlet, constitutes a most valuable endorsement. In this work the speed must be under positive and accurate control and the power must be absolutely reliable. This bulletin illustrates the attachments of the motors to the presses and by aid of engravings the construction and operation of the motors and controllers are explained. Diagrams show the saving in current which is effected by the "teaser" method of control.

Pratt Institute, Department of Science and Technology.—We have received from Professor A. L. Williston, Director of the Department of Science and Technology at Pratt Institute, Brooklyn, a copy of the annual circular of the department, which describes more fully than previous circulars what the institute is doing in the field of technical education as well as in its evening science and trade classes. The courses offered at Pratt Institute are intended to prepare young men for industrial or business pursuits, and they also tend to develop and cultivate those qualities of mind and character that are of greatest value in any walk of life. The class-room, laboratory and shop training is planned throughout with a view of making the student think and act for himself. The object is to give him "the power to conceive; to plan in detail; and to execute with accuracy"; for these powers are the foundation of all true ability. The primary aim of the courses in steam and machine design and in applied electricity is to furnish as sound and complete a technical and mechanical training as is possible in the limits of two years, and it is intended for those who can not devote the time required to complete a four-year course. It is intended to fit young men for positions as designers of machinery or supervisors of its construction or operation. Pratt Institute does not give as thorough training in two years as may be had from the technical schools with four-year courses, but its plan when carefully studied will be found suggestive for all technical courses wherein there is usually too strong a tendency to teach facts rather than methods of thought.

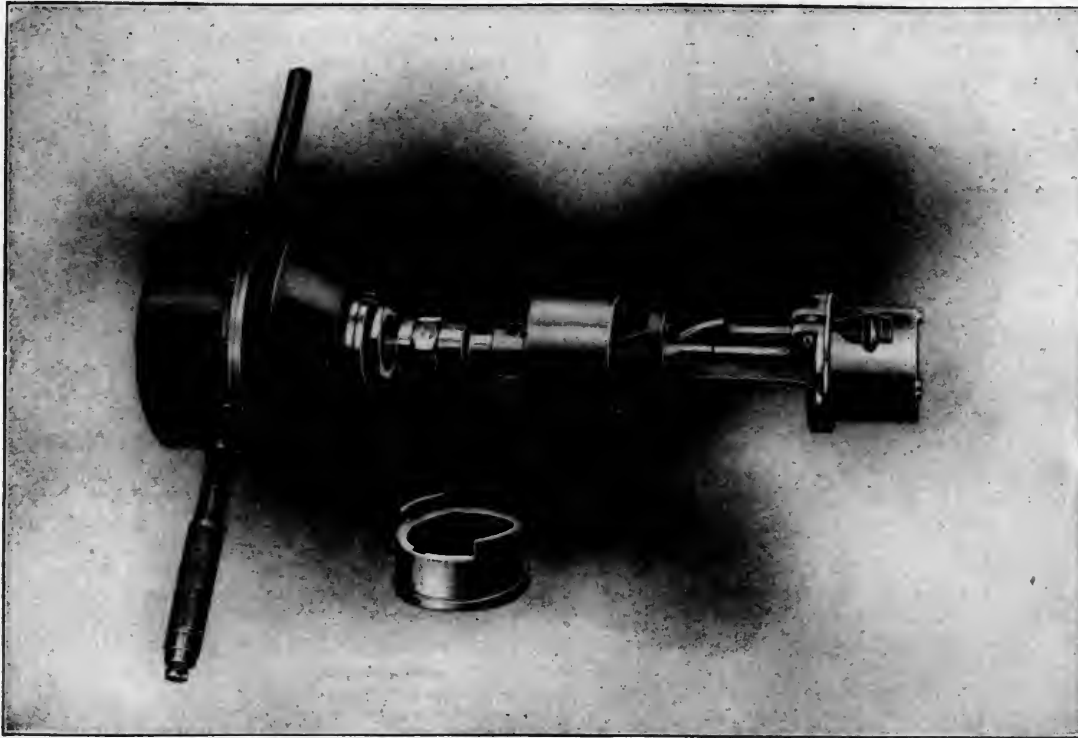


Dixon's Graphite Productions.—The Joseph Dixon Crucible Co. have recently issued a new general catalogue of the productions of their works. It is standard size, 6 by 9 inches, and has 62 pages with illustrated descriptions of their specialties. The list is too long to give completely here, but our readers are probably most interested in the following subjects: American Graphite Pencils, Axle Grease, Belt Dressing, Brazing Crucibles, Bricks for Furnace Linings, Car Grease, Crucible Clay and Graphite Mixtures, Graphite for Gas Engine Cylinders, Graphite Paint, Gear Grease, Hot-Box Grease, Lubricating Graphite, Lubricating Oil, Pipe Joint Compound and Smoke-Stack Paint. There are so many of these products which are used by our readers that a copy of the pamphlet will be sure to be found convenient and worth sending for.

THE HENRIKSON FLUE CUTTER.

Chicago Pneumatic Tool Company.

The flue cutter illustrated here is newly patented and is known as the Henrikson. The size shown by the engraving is for $4\frac{1}{2}$ -inch flues, but the device is also made in smaller sizes, particularly for use in cutting off locomotive flues. It has been adopted generally for flue cutting in the shops of the Chicago & Northwestern Railroad. It is made in any size to meet the requirements of purchasers. Reference to the engraving will show that the flue is cut by a sharpened wheel fed against the flue by means of a cylinder and piston seen at the center of the machine. The air motor revolves the cutter



The Henrikson Flue Cutter—The Chicago Pneumatic Tool Co.

Electric Railway Number of Cassier's Magazine.—This is a remarkably fine issue. It contains eighteen articles on different phases of the subject of electric railways, each having been prepared by a recognized authority, and it is an excellent, exceedingly valuable record. It contains 292 pages of reading matter and over 200 engravings.

The Watson-Stillman Co. have issued a new catalogue in accordance with their plan of publishing sectional catalogues subsidiary to their illustrated index or catalogue of catalogues. The one before us is an assortment of illustrated sheets grouped under the title "Catalogue No. 54," and covers the subject of hydraulic jacks. It has an introduction or preface and an alphabetical index, and includes additions to former lists of jacks arranged to be uniform with previous lists. Entirely new matter is presented on pages 18 to 26. New tools are shown on pages 34, 35 and 36. On page 51 is an announcement to the effect that the firm will rent jacks for temporary use to those who need them only occasionally, and the prices given are reasonable. The catalogue is indexed and it is also provided with an alphabetical list of the large variety of jacks and presses made by this concern, each device being illustrated upon a separate sheet which may be obtained upon request by giving the number of the one desired. These sheets are used in the sectional catalogues, which are issued as occasion requires. The sectional plan is an admirable one for a firm manufacturing such a large variety of product which is used in nearly all branches of manufacturing. The engravings are uniformly excellent wood cuts which are noteworthy for their clearness.

and at the same time the air pressure feeds it to its work. This machine will cut the flues either on the inside or the outside of the flue sheet and it has been found very efficient when used on $4\frac{1}{2}$ -inch flues, which are cut off in about 20 seconds. Smaller locomotive flues are cut off in much less time, but we are not told exactly what time is required. Motive power officers will appreciate this device because of its very great advantages over hand work, and it possesses a strong advantage in saving expense in repairing flues because of its ability to cut them off close to the sheet, which effects an important economy of material.

The Ajax Metal Company has not joined the "Brass Trust" and has no intention of doing so. Reports have been circulated to the effect that they had done so, but we are able to state positively that they are not true. The company is not in any way, shape or manner connected with any brass trust and will not countenance a proposition to join one.

Service stripes are to be worn by the uniformed employees of the Baltimore & Ohio Railroad. A gold stripe will indicate five years of service, and a silver stripe two years. We are informed that some of the conductors are entitled to wear from seven to nine stripes. The company will furnish conductors, brakemen and baggagemen with badges, so that they may be readily distinguished by patrons.

A NEW STREET RAILWAY GENERATOR.

The Bullock Electric Manufacturing Company.

Encouraged by their success of the past ten years in other lines of electrical equipment, this company has now determined to enter the railway field. To this end a complete line of engine type railway generators has been designed up to and including the 800-K. W. unit.

Bullock's railway generators will possess all of the features that have made its present standard machines so popular, and also some new features that cannot be found in other machines.

Among the more important may be mentioned a scheme for oscillating the brush holder mechanism in a direction parallel with the shaft. The movement is very slow and results in constantly changing the line of travel over the commutator



A New Street Railway Generator.

The Bullock Electric Mfg. Co.

face and thus removes all tendency to cut or groove the latter. The action is the same as secured by the end play of an armature in a belted generator or that produced by the electromagnetic device used at the end of the shaft on rotary transformers, and which is recognized by engineers as a means of greatly prolonging the life of the commutator.

The pole pieces and coils may be removed without disturbing the yoke or armature, and with two of them removed it is possible to remove one or more armature coils should repairs be necessary.

The armature coils are made of continuous bars of copper without joints between the commutator connections, which materially adds to the life of the machine. These coils are all thoroughly insulated, pressed and baked before being placed on the core, no additional core insulation being necessary.

All armatures are thoroughly ventilated by slots perpendicular to the shaft through which the air rushes when the machine is in operation.

A liberal rating permits of constant operation at full load with low temperature rise.

One of the 800-K. W. machines has been sold to the Oakland Rapid Transit Company, of Oakland, Cal., and is shown in the engraving. This machine operates at a speed of 80 R. P. M. and at this speed develops 550 volts at no load.

It is over-compounded for a rise of 50 volts at full load, making the full-load voltage 600.

EQUIPMENT AND MANUFACTURING NOTES.

The New York office of the National Electric Car Lighting Co. has been removed to the offices of the Electric Axle Light and Power Co., 100 Broadway.

The shops and yards of the Pittsburgh & Lake Erie at McKees Rocks are to be rebuilt, and a refrigerating plant is to be installed, the cost of the entire improvements being placed at \$500,000.

Mr. B. F. Pilson, of Richmond, Va., who has for a number of years represented the Ajax Metal Co. in the South, has been appointed General Contracting Agent of that company. He has been very successful, and this appointment shows the appreciation of his valuable services.

The St. Louis Railway Club has had placed at its disposal a free scholarship in Blee Military Academy, which covers all necessary expenses for a student sent by the club. This is available for the son of a member of the club who shall receive the appointment through the executive committee and pass the necessary examination.

The Ajax Metal Co. have installed an exhibit in "Section M-13, Main Building," of the National Export Exposition, now being held in Philadelphia, to which railroad managers and motive power officers are invited. A representative of the company is in attendance and at the service of visitors. Facilities for correspondence are provided and every attention will be given those who avail themselves of this invitation.

The Joseph Dixon Crucible Co.—"Making Records" is the title of a little pamphlet of 32 pages issued by this concern to exhibit the written opinions of a large number of locomotive engineers who have used graphite for the lubrication of locomotives. The names of the writers are not given, but they are not needed to give force to the reports. Every motive power officer not using graphite should procure and examine this pamphlet. The address of the Joseph Dixon Crucible Co. is Jersey City, N. J.

The Baltimore & Ohio Railroad has recently placed several orders for new freight equipment to meet the excessive demand for cars. The South Baltimore Car Works are building 1,200 Baltimore & Ohio standard box cars. The American Car and Foundry Company has an order for 150 refrigerator cars and 10 improved horse cars have also been ordered. The road has received only 1,000 of the 6,000 Schoen steel cars ordered some time ago, and when the remaining 5,000 are delivered, will have 6,360 cars to add to the 45,000 now in use.

William H. Wood, Hydraulic Engineer, Media, Pa., has received orders to place one of his hydraulic riveting plants in the Coatesville Boiler Works, Coatesville, Pa., and he is putting in two hydraulic riveting plants for the Aultman & Taylor Machinery Co., of Mansfield, O., and one for the Edw. Keeler Co., of Williamsport, Pa. He has also recently started one of his hydraulic riveting plants for Thos. C. Basshor & Co., of Baltimore, Md., one for the Boston Navy Yard, U. S. Government, and a plant for Orr & Sembower, of Reading, Pa.

The new Boyer long stroke hammer, made by the Chicago Pneumatic Tool Co., has made an excellent record at the works of the Pressed Steel Car Co. at Pittsburgh, showing that it may be used by men who are not expert riveters and that the machines may be used for long, continuous work, without failure. One of them was put into use at these works at noon August 21 and was not out of service at all for seven days and nights. It may have run much longer than that, but of this we are not informed. The rivets were $\frac{3}{4}$ -inch in diameter and, as we understand it, the machine was not stopped and did not break down in this time.

The Bullock Electric Mfg. Co. reports sales for August

amounting to 52 machines, ranging in capacity from $2\frac{1}{2}$ to 800 kilowatts. The orders came from points in widely separated parts of the United States, and two were from Great Britain. The British orders were for "teaser" equipments for driving large printing presses, one 50-H.P. equipment for the "Free Press" of Aberdeen, Scotland, and four 50-H.P. equipments for the "Scotsman" of Edinburgh. The Bullock Electric Mfg. Co. has just issued Bulletin No. 2432, which may be had on request of the general office in Cincinnati, Ohio.

The firm of Dietz, Schumacher & Boye, manufacturers of machine tools at Queen City Ave. and Buck St., Cincinnati, has been dissolved and a new partnership formed under the name of Schumacher & Boye, Mr. Jacob Dietz having retired from the concern. The new firm assumes all indebtedness of the old one and obligations due are payable to the new firm.

The phenomenal rapidity of the introduction of pneumatic tools has been remarked in these columns. The statement is now made by the Chicago Pneumatic Tool Co. that their sales for August last were greater than for the entire year 1897. This is probably due to the increasing number of these tools required by those who have used a few and found the possibilities of reducing costs to demand increasing the pneumatic equipment. The sales of this company have increased every month since the introduction of the pneumatic devices, and they are now considered indispensable as labor savers.

The New York office of Valentine & Company, the well-known varnish and color manufacturers, recently reported the purchase of additional property adjoining their Brooklyn works, and the filing of plans with the Building Department for a large two-story building thereon. We now learn that even this extension will not suffice for the needs of their business, and that they have just filed plans for the erection at their Chicago works of a large three-story building; the ground floor to be devoted to tanks and the storage of varnish, the other two floors to contain machinery and other facilities for the grinding and packing of colors and paints.

The Chicago Pneumatic Tool Co. has installed a comprehensive exhibit of pneumatic tools at the National Export Exposition at Philadelphia, including the new Boyer long stroke hammer for driving rivets of diameters from $\frac{3}{4}$ to $1\frac{1}{4}$ inches, the new reversible wood boring machine, the Henrickson flue cutter driven by a reversible motor, the well-known Boyer drills and hammers for clipping and caulking, the Haeseler piston drills, Phoenix rotary drills and other pneumatic appliances. The air supply will be furnished by an electrically driven air compressor. The exhibit is under the charge of a competent attendant, and is intended to furnish practical demonstrations of the value and convenience of these devices to foreigners and others interested in the subject.

The Baltimore & Ohio Railroad has ordered thirty four-cylinder compound consolidation freight locomotives from the Baldwin Locomotive Works, for December and January delivery. The cylinders are to be 15 inches and 25 inches in diameter by 30 inches stroke. The total weight of the engine, exclusive of tender, is to be 176,000 pounds. The drivers are 54 inches in diameter with a driving wheel base of 15 feet 4 inches, and total wheel base of 23 feet 8 inches. The tenders will have 5,000 gallons water capacity, 8 tons coal capacity, and weigh 95,000 pounds. The boilers are to be of the extended wagon top type, 64 inches in diameter at the front end. The firebox is to be 41 inches wide and 118 inches long. When these locomotives are completed the Baltimore & Ohio Railroad will have 137 freight engines, each exceeding 175,000 pounds in weight.

The H. K. Porter Co., builders of light locomotives, are now engaged upon an order for three steel works locomotives for the Newburgh, Ohio, works of the American Steel & Wire Co.; also on an order of five contractors' locomotives for Messrs. Nawn & Brock, of Boston, for use on a large water-works contract in Brighton. They are also building a little engine for 18 inch gauge, having cylinders 6 by 10 inches, for the French Rand Gold Mining Co. of Johannesburg, South Africa, and they have just shipped a 7 by 12 inch locomotive for 30 inch gauge to Japan. A 7 by 12 inch compressed air locomotive for 21 inch

gauge has just been shipped to the Commonwealth Iron Co. for work at their mines at Norway, Michigan. This firm is also reaching foreign trade. A 11 by 14 inch consolidation locomotive has recently been shipped to Russia to run on track with a gauge of $29\frac{1}{2}$ inches.

The Russell Snow Plow Co., Room 751 Tremont Building, Boston, has received a large number of orders, of which the following is a list: Long Island Railroad, one Russell standard double track plow, size No. 2; New York, New Haven & Hartford Railroad, one Russell standard single track plow, size No. 2, to be equipped with Russell air flanger (double) and Westinghouse air brakes; Rutland Railroad, one Russell wing-elevator snow plow, size No. 2; Fitchburg Railroad, two Russell standard double track plows, size No. 2, to be equipped with Russell air flangers, Westinghouse brakes and Westinghouse train air signal apparatus; Boston & Albany Railroad, one Russell standard double track plow, size No. 3, to be equipped with Russell air flanger and Westinghouse air brakes; Copper Range Railroad, one Russell wing-elevator plow, size No. 1, Special, to be equipped with Russell air flanger, Westinghouse air brakes and Westinghouse train air signal apparatus; Lake Shore & Michigan Southern Railroad, one Russell standard double track plow, size No. 4, to be equipped with Russell air flanger, Westinghouse air brakes, Westinghouse train air signal apparatus and Gould automatic couplers; Philadelphia & Reading, two Russell standard double track plows, size No. 2, to be equipped with Westinghouse air brakes, Westinghouse train air signal apparatus and Gould automatic couplers; and Delaware, Lackawanna & Western Railroad, three Russell standard double track plows, size No. 2, to be equipped with Westinghouse train air signal apparatus.

The Rhode Island Locomotive Works, now operated by the International Power Co., have just received an order for ten 10-wheel freight compounds for the Chicago Great Western, to be built in accordance with the Rhode Island system of compounding, which has been modified and improved without, however, changing the essentials. These engines will have two cylinders, 22 and 35 by 28, and were designed to be equivalent in cylinder power to a 20 by 28 inch simple engine, the boiler pressure being 200 pounds. The driving wheels have cast steel centers and are 63 inches in diameter over the tires. The total weight will be about 160,000 pounds, of which about 120,000 will be on the drivers and about 40,000 on the trucks. The boilers will be of the extended wagon top, radial stayed type, 64 inches in diameter at the smallest ring and having a total heating surface of 2,600 square feet. The grate is 112 by 42 inches, having an area of 32.6 square feet. The driving axle journals are 9 by 12 inches, and these axles and the crank pins are to be of the Coffin process steel. The tenders will have frames of steel channels, and the tanks will carry 6,000 gallons. These works are completing an order for 22 locomotives for the Wabash, 4 of which are compounds. The recent order for 4 heavy freight engines for the "Big Four" has been increased to 10, and in addition to these orders the shops are busy with an order for 21 boilers for the Erie, 16 of which are of the Wootten type and 5 are extended wagon tops. The equipment of the Rhode Island Works has been improved by the addition of a number of new tools, including rod and wheel borers, a large hydraulic wheel press and a set of 16 foot bending rolls. The 12 foot hydraulic riveter formerly in use at the Grant Locomotive Works, has been purchased complete and is now being set up. The flanging work on boilers is all done on the large flanging press that was used before the change in management. The new management of the Rhode Island Locomotive Works includes Mr. Joseph Lithgoe as Superintendent, and a large number of the old foremen and many of the former shop hands have returned. The shops appear to be exceedingly busy and prosperous.

WANTED.

A situation by a foreman boiler maker, acquainted with all modern appliances for economical construction of boilers. Extended experience in locomotive building and railroad shops with both day work and piece work systems. Good references. Address "Energy," care "American Engineer and Railroad Journal," 140 Nassau Street, New York.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

NOVEMBER, 1899.

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TEN-WHEEL PASSENGER LOCOMOTIVES.

Lake Shore & Michigan Southern Ry.
Built by the Brooks Locomotive Works.

Mr. W. H. Marshall, Superintendent of Motive Power.

Through the courtesy of Mr. W. H. Marshall, Superintendent of Motive Power of the Lake Shore, and the Brooks Locomotive Works, the accompanying engravings of one of eleven new 10-wheel passenger locomotives for that road are published.

These are very powerful locomotives, and are the heaviest in this class of service, with the exception of the Schenectady 10-wheel compounds built in 1897 for the Northern Pacific. They have more heating surface than any other passenger engines of which we have record. With 20 by 28 inch cylinders, 210 pounds steam pressure and 80-inch driving wheels, they ought to be able to do the work expected of them with ease. These engines are about 25 per cent. stronger in tractive power (about 25,000 lbs. tractive power) than any passenger engines now on the road, and they have about 60 per cent. more boiler power based on the heating surface, as well as a greater power based on grate area. They are not designed to make phenomenal speeds, but simply to haul the heaviest trains at their present schedules, and have enough reserve power to make up time when there is any occasion to do so. The present passenger engines will handle about 12 cars as a maximum on schedules of slightly more than 40 miles per hour, the new ones are expected to be able to haul 14 cars at 60 miles per hour when occasion requires, and the same number at the schedule speeds with a margin of power to spare. An eight-wheel engine cannot be expected to do this. The trains sometimes have more than 12 cars, and it has been necessary to run them in two sections.

The 10-wheel type was selected because it permits of putting more weight into the boiler than is permissible with the eight-wheel type or a mogul, on the assumption that the upper limit of total weight is not specified.

The boiler is large. It is of the extended wagon top, radial stay type, with the firebox over the frames. The diameter of the front end of the shell is 66 inches, and at the throat 74 inches. There is ample room at the back ends of the tubes for water space and circulation, the boiler being unusually wide at the throat. The height of the center of the boiler

above the rails is 9 ft. 2 in. The large heating surface, 2917 sq. ft., has already received comment. Fifteen feet as the length of tubes is rather unusual, but this was exceeded by the Baldwin Atlantic type passenger engines for the Burlington (American Engineer, May, 1899), which have tubes 16 ft. long. It is believed that increasing lengths of tubes will probably be a feature of future designs. Butt joints are used on all the horizontal boiler seams. Mr. Marshall believes in following theoretically correct practice in this regard, as a result of experience which shows that trouble usually results when theory is departed from in boiler construction.

Among the details several good features are noticed, such as enlarged cross-head fits for the piston rods, extended piston rods, enlarged wheel fits for the crank pins and axles, large (9 by 12-inch) driving journals, and 6 by 12-inch engine truck journals. Cast steel is used to an unusual extent to save weight. The equalizers and fulcrums in connection with the under-hung spring rigging are of this material. The saving of unnecessary weight has been studied with great care. The valves have Allen ports, and are provided with the Richardson balance. The link radius is short. The brake shoes are placed back of the driving wheels, giving an upward thrust to the hangers when the brakes are applied.

The large driving wheels necessitated a long wheel base, the driving wheel base being 16 ft. 6 in., the engine as a whole being 41 ft. 4½ in. long. The cab has a full deck, making a comfortable arrangement for the men. The tender journals are larger than usual for a 5,000 gallon tank, being 5½ by 10 inches. The reason for using this heavy axle is that the largest size previously used on this road was 4¼ by 8 inches, and it was necessary to increase this for these tenders. In making them larger, provision was made for trucks which should be strong enough for the heaviest tender that will be required, which was wise. This road has already planned tenders for 6,000 gallons and 12 tons of coal for freight engines, and these trucks are to be interchangeable in every respect between passenger and freight service.

This design is characteristic of Mr. Marshall's work. It includes no novelties or radical departures, but embodies careful balancing of the factors which go to make up a powerful locomotive with a minimum of unproductive weight. The engines are exceedingly well proportioned and very handsome.

Description.

Gauge.....	4 ft. 8½ in.
Kind of fuel to be used.....	Bituminous coal
Weight on drivers.....	133,000 lbs.
Weight on trucks	38,600 lbs.
Weight, total	171,800 lbs.
Weight, tender loaded	112,000 lbs.

General Dimensions.

Wheel base, total of engine.....	27 ft. 4 in.
Wheel base, driving	16 ft. 6 in.
Wheel base, total, engine and tender.....	55 ft. 2¼ in.
Length over all, engine.....	41 ft. 4½ in.
Length over all, total, engine and tender.....	64 ft. 4½ in.
Height, center of boiler above rails.....	9 ft. 2 in.
Height of stack above rails.....	14 ft. 11 in.
Heating surface, firebox and arch flues.....	223 sq. ft.
Heating surface, tubes.....	2,694 sq. ft.
Heating surface, total.....	2,917 sq. ft.
Grate area	33.6 sq. ft.

Wheels and Journals.

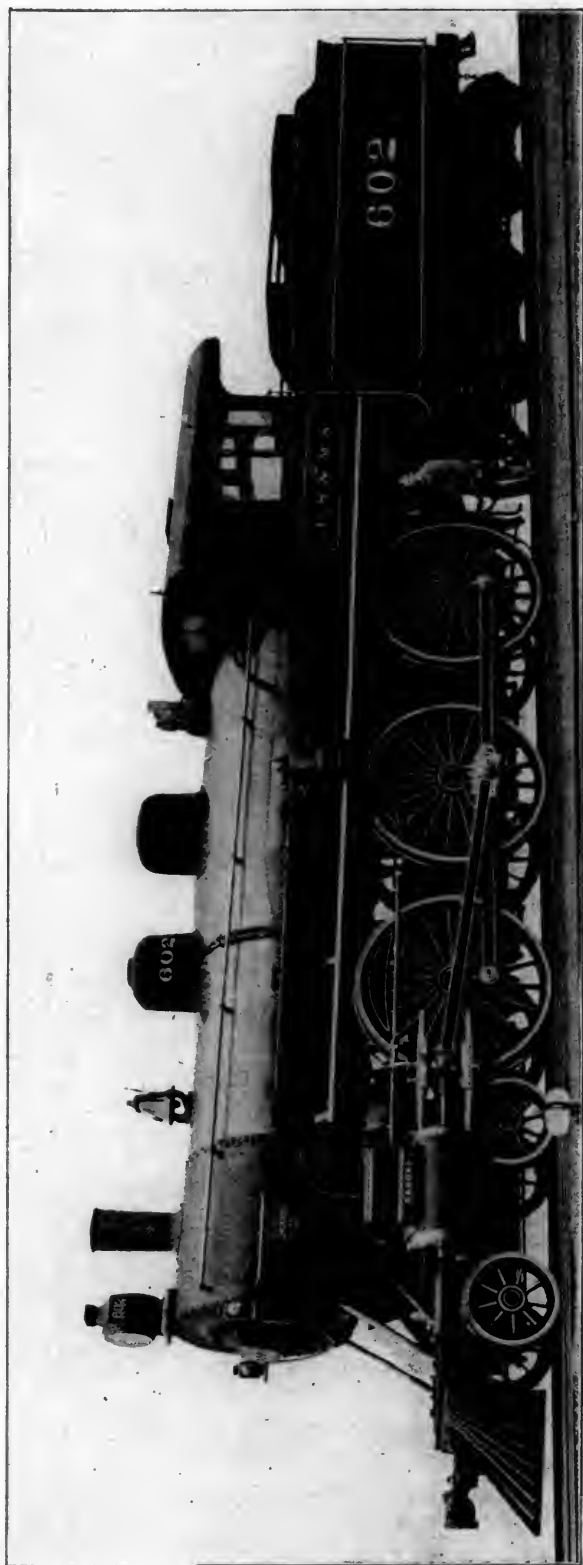
Drivers, diameter.....	80 in.
Drivers, material of centres.....	Cast steel
Truck wheels, diameter.....	36 in.
Journals, driving axle.....	9 in. by 12 in.
Journals, truck axle.....	6 in. by 12 in.
Main crank pin, size.....	6¼ in. by 6 in.
Main coupling pin, size.....	7¼ in. by 4½ in.
Main pin, diameter wheel fit.....	7½ in.

Cylinders.

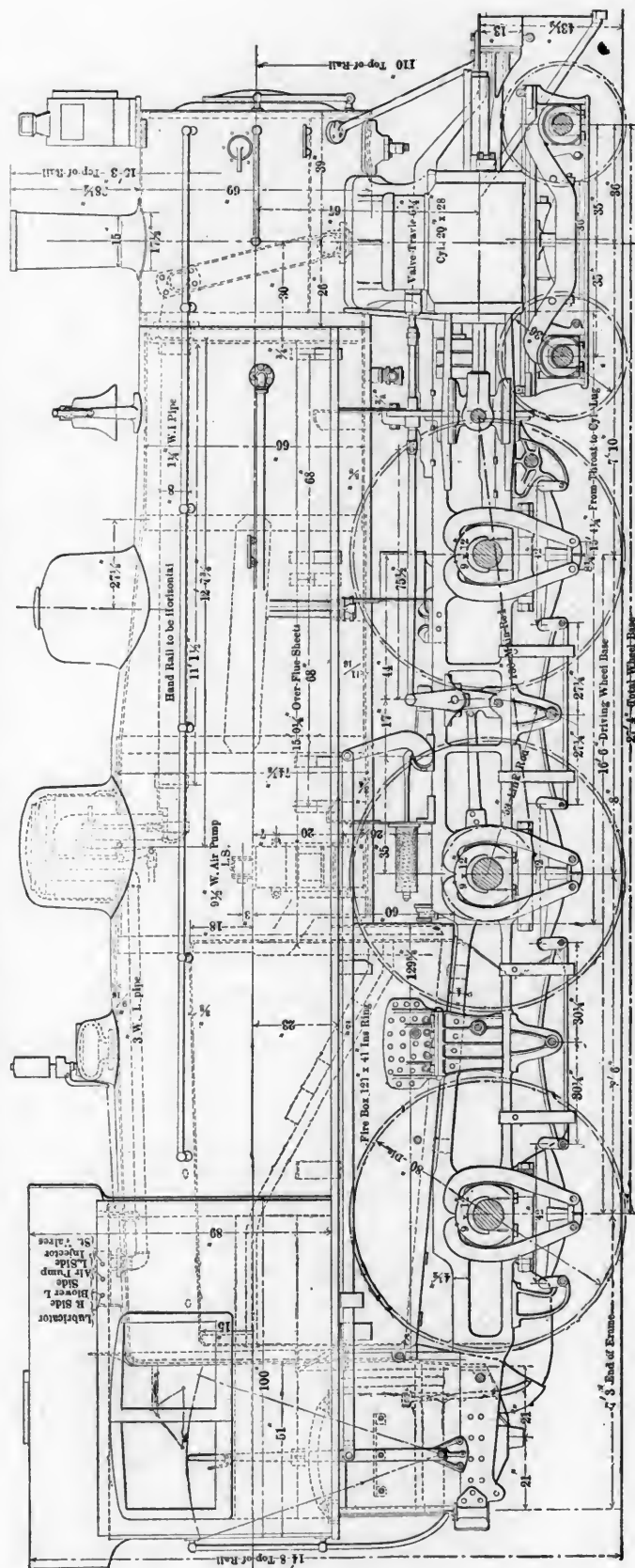
Cylinders, diameter	20 in.
Piston, stroke	28 in.
Piston rod, diameter	3½ in.
Main rod, length, centre to centre.....	133 in.
Steam ports, length.....	19 in.
Steam ports, width.....	1½ in.
Exhaust ports, length.....	19 in.
Exhaust ports, width.....	2¾ in.
Bridge, width.....	1½ in.

Valves.

Valves, kind of.....	Allen-Richardson balanced
Valves, greatest travel.....	6.2 in.
Valves, outside lap.....	1¼ in.
Valves, inside clearance.....	¾ in.
Lead in full gear.....	1/16 in. negative



Powerful 10-Wheel Passenger Locomotive—Lake Shore & Michigan Southern Ry.



Powerful 10-Wheel Passenger Locomotive—Lake Shore & Michigan Southern Ry.

W. H. MARSHALL, *Superintendent Motive Power.*

BROOKS LOCOMOTIVE WORKS, Builders.

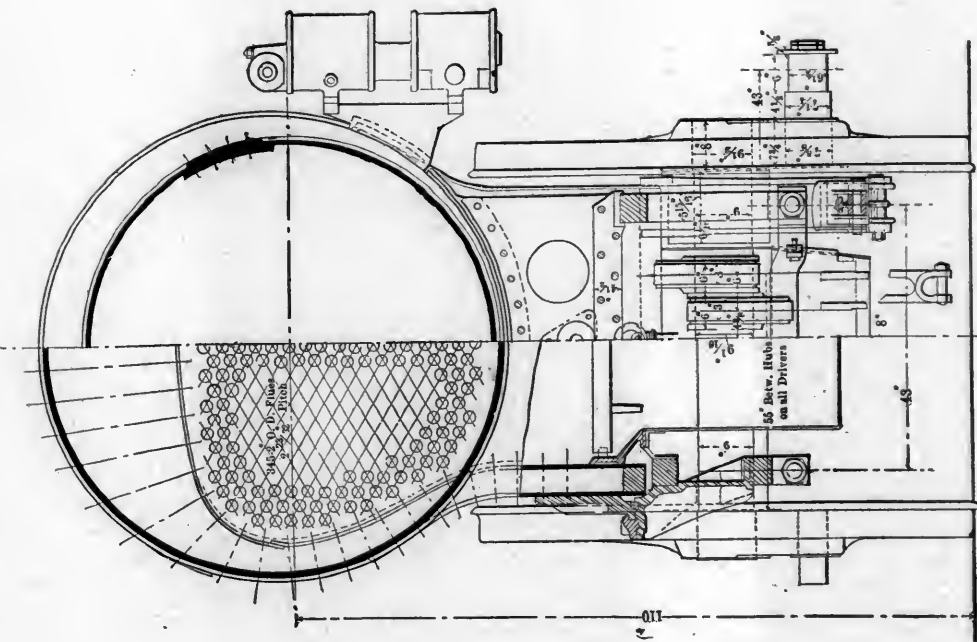
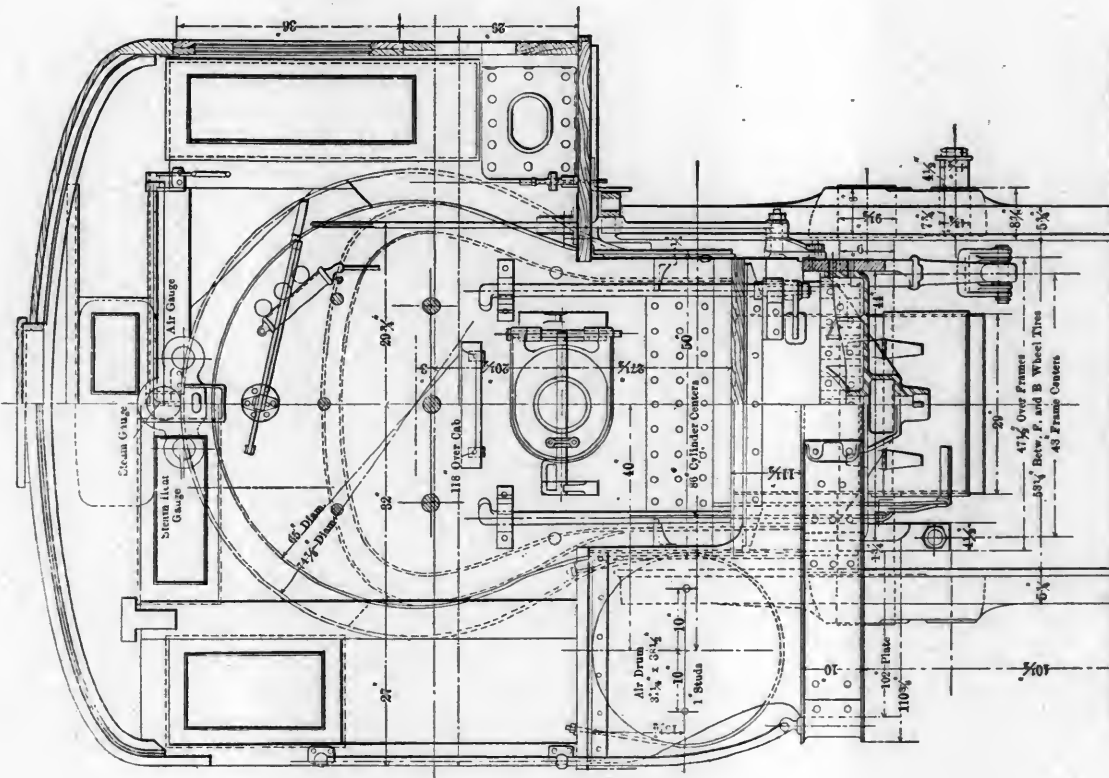
Boiler.	
Boiler, type of.....	Extended wagon top
Boiler, working steam pressure.....	210 lbs.
Boiler, material in barrel.....	Steel
Boiler, thickness of material in barrel.....	$\frac{5}{8}$ in., $11\frac{1}{16}$ in., $\frac{3}{4}$ in.
Boiler, thickness of tube sheet.....	$\frac{3}{4}$ in.
Boiler, diameter of barrel, front.....	66 in.
Boiler, diameter of barrel at throat.....	74 $\frac{1}{2}$ in.
Crown sheet, stayed with.....	Radial stays
Dome, diameter.....	30 in.

Firebox.	
Firebox, type.....	Over frames
Firebox, length.....	121 in.
Firebox, width.....	41 in.
Firebox, depth, front.....	78 in.
Firebox, depth, back.....	63 $\frac{1}{2}$ in.
Firebox, material.....	Steel
Firebox, thickness of sheet.....	Tube, $\frac{5}{8}$ in.; sides, back and top, $\frac{3}{4}$ in.
Firebox, brick arch.....	On water tubes

Firebox, mud ring, width.....	Back, $3\frac{1}{2}$ in.; front and sides, 4 in.
Grates, kind of.....	Cast iron rocking
Tubes, number of.....	345
Tubes, material.....	Charcoal iron
Tubes, outside diameter.....	2 in.
Tubes, length over tube sheets.....	15 ft. $\frac{1}{4}$ in.

Smokebox.	
Smokebox, diameter, outside.....	69 in.
Smokebox, length from flue sheet.....	69 in.

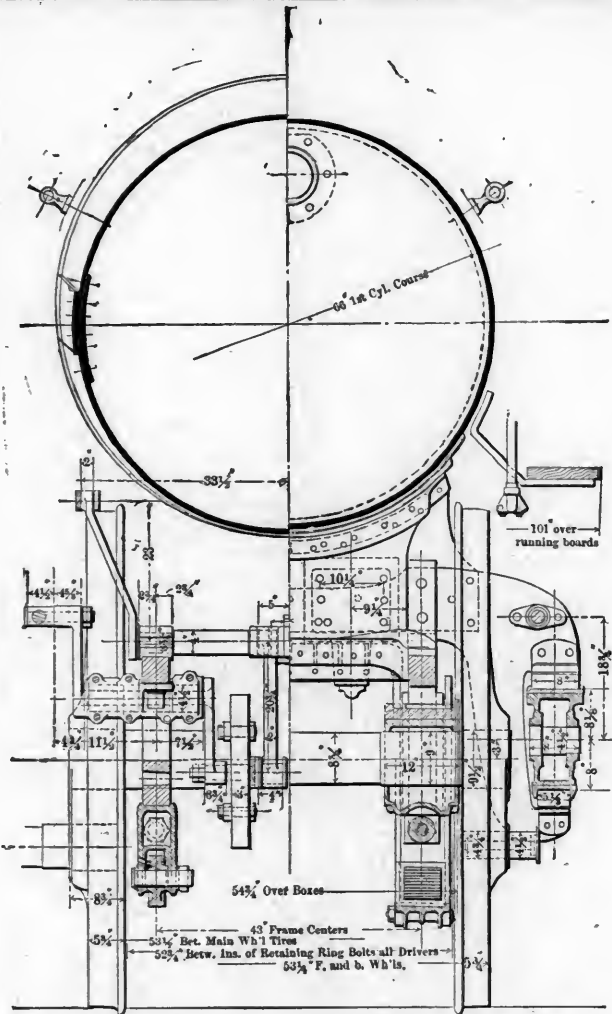
Other Parts.	
Exhaust nozzle, single or double.....	Single
Exhaust nozzle, variable or permanent.....	Permanent
Exhaust nozzle, diameter.....	5 $\frac{1}{2}$ in.
Exhaust nozzle, distance of tip below center of boiler.....	7 in.
Netting, wire or plate.....	Wire
Netting, size of mesh or perforation.....	2 $\frac{1}{2}$ by 2 $\frac{1}{2}$ in.
Stack, straight or taper.....	Steel, taper
Stack, least diameter.....	15 in.
Stack, greatest diameter.....	16 $\frac{1}{2}$ in.
Stack, height above smokebox.....	34 $\frac{1}{2}$ in.



Ten-Wheel Passenger Locomotive—Lake Shore & Michigan Southern Ry.

Transverse Sections and Rear View.

(For Front End Section see page 346.)



10-Wheel Passenger Locomotive—L. S. & M. S. Ry.

Tender.

Type	8-wheel, steel frame
Tank, type	"U" shape
Tank, capacity for water.....	5,000 gal.
Tank, capacity for coal.....	9½ tons
Tank, material	Steel
Tank, thickness of sheets.....	3/16 in. and ¼ in.
Type of under frame.....	Steel channel
Type of springs	Triple elliptic
Diameter of wheels.....	36 in.
Diameter and length of journals.....	5½ in. by 10 in.
Distance between centers of journals.....	5 ft. 6 in.
Diameter of wheel fit on axle.....	6½ in.
Diameter of center of axle.....	5½ in.
Length of tender over bumper beams.....	21 ft. 2 in.
Length of tank.....	19 ft. 6 in.
Width of tank	9 ft. 10 in.
Height of tank, not including collar	54 in.
Type of draw gear	Gould

Mr. Albert J. Earling, who has been elected to the presidency of the Chicago, Milwaukee & St. Paul, to succeed Mr. Roswell Miller, has had an interesting and unique career. He began railroad service with this road as a telegraph operator in 1866 at the age of 18 and never has had any other employer. His advancement is well earned and the selection is an admirable example of what ought to be the rule on all railroads, the advancement of men within the ranks, even to the very highest positions. Mr. Earling is not only a good railroad man and eminently fitted to preside over the interests of one of the best railroads in the country, but he knows more about this road than anyone else because of having filled all grades of positions from the lowest to the highest in its operation. His success is due to ability and carefulness, combined with thorough knowledge of the details of operation. He was a telegraph operator for six years, a train despatcher for five years, and assistant superintendent for four years. In 1882 he was made superintendent of a division; in 1884 he became assistant general superintendent; in 1888, general superintendent; in 1890, general manager, and in 1895, second vice-president.

PRESIDENT FISH ON PROFIT-SHARING FOR RAILROADS.

"Is profit-sharing on railroads practical? If so how can it best be adapted?" was one of the topical questions recently propounded by the St. Louis Railway Club. Mr. Stuyvesant Fish, president of the Illinois Central Railroad, answered it as follows:

"In my opinion it is not practical because of the difference in the length of service, character of service, method and the times of employing men engaged in the work. For instance, our out-of-door work on the track is practically suspended in the Northern States for some months together, track forces being disbanded or reduced very materially every autumn. Hence, through no fault of their own, large numbers of men, while working year after year for the company, are not in continuous employment in the service and cannot get the benefits which ought to accrue for continuous employment. On the other hand, it would not be fair to those who are continuously employed, day in and day out, year after year, to put them on a par with these track laborers whose employment is, after all, only occasional. Instances might be multiplied and run through all branches of the service.

"More than twenty years ago we endeavored to work out something of this sort on the old Chicago, St. Louis & New Orleans Railroad, then running from Cairo to New Orleans, but had to give up the attempt.

"The Illinois Central has nothing in its service approaching to profit sharing, but has, for several years past, encouraged and aided those in its employ in purchasing shares of the company's stock."

Notwithstanding the great importance of statistics in the form of concise figures of performance and cost of doing work the records of a department of a large organization which permit of instant comparisons are seldom obtainable. A great deal of thought is put into systems of records, but there are probably few systems in use which may not be improved. The following quotation, offered by J. F. Deems at the recent Master Mechanics' convention, may be somewhat overdrawn, but it points forcibly to the state of the statistician's art. "What practical railroad manager has not been deviled by the statistician, annoyed, bedeviled, disgusted? Yet the weary course goes on. Away up in the loft of some office at the cross-roads country station, in the grime and smoke of the store clerk's shop, overhead in the division superintendent's office, at the shipping clerks' desks, in the maintenance of way departments—everybody, everywhere in some way or other, is making statistics. We have spent one dollar and we spend two dollars more of the stockholders' money just to explain to them where the first dollar went to."

At the completion of tests recently made on Babcock & Wilcox water-tube boilers, in the British twin-screw gun-boat Sheldrake, some interesting experiments were made. One was to ascertain in what time steam could be raised to a pressure of 140 lbs., from water at 70 deg. F. This was found to take just 23 minutes. A stopping and starting test was then tried, in which the engines were suddenly stopped from full speed. The tube, front, and uptake doors were simultaneously opened and the ash-pit door closed. The increased pressure on the gauge did not exceed five pounds; neither did the safety valve lift. A test was then made to see how soon the operation of drawing a tube could be commenced, and how quickly a tube could be drawn from the boiler after the fires were suddenly drawn and water blown out. Several caps were removed ready for tube drawing in 24 minutes, and three tubes were afterward drawn in 11, 10 and 9 minutes, respectively.

WIDER FIREBOXES.

By William Forsyth.

In the United States for many years the width of locomotive fireboxes was restricted by the distance between frames, the box extending down below the lower frame bars and the inside width of the firebox with this construction was about 33 inches. The grate area with a box 6 ft. long was $16\frac{1}{2}$ sq. ft. and with one 7 ft. long it was $19\frac{1}{4}$ sq. ft. With larger engines it was found necessary to increase the grate area, and the firebox was placed on top of the frames and flush with their outside faces, thus securing an inside width of firebox of 42 inches, and it being clear of the axles any convenient length could be used. The box was made 8 or 9 ft. long, and the grate area so obtained was from 28 to 31 sq. ft. This practice was coming into general use in 1885, when 19x24 in. cylinders were considered large, and 160 lbs. boiler pressure a high one. Notwithstanding the continued enlargement of cylinders and boilers since that time it is a remarkable fact that for bituminous coal, locomotive builders still retain the same width of firebox as used 14 or 15 years ago. The width of firebox now seems to be limited to the distance between the outside faces of frames. The difficulties in construction met with in extending the firebox beyond the frames have been easily overcome in the extreme widths used on the numerous Wooten fireboxes, 8 ft. wide, which have already been built. These large fireboxes have been generally adopted by all the roads in the anthracite coal region, and the practice in the United States may now be said to be the use of fireboxes 8 ft. wide for anthracite coal, and boxes 3 ft. 6 in. wide for bituminous coal. This arbitrary limitation of the width of the firebox to 3 ft. 6 in. regardless of the size of the engine is believed to be a mistake which must soon be recognized by those who are endeavoring to obtain the maximum economy in coal burning. The large engines which have been built in recent years, when compared with smaller engines, have shown such improved economy in cost of coal per ton-mile that the effort to obtain the best possible evaporation has to some extent been neglected. The large boilers have had the advantages of greatly increased heating surface in the tubes, and for this reason the coal economy has been maintained as before, notwithstanding the fact that the rate of combustion must have been increased. The time will soon come when small engines will be obsolete and large engines will only be compared with other engines of equal size, and the best coal economy will then be found where the grate area has been properly proportioned to the steam consumption of the cylinders.

The two principal objections to very high rates of combustion on locomotives are, first, the heavy draft required; it pulls large quantities of sparks into the smokebox, taxing the spark-arresting device so that it must be modified in some way, which will invariably interfere with economical coal burning; besides the spark loss in fuel is considerable, and probably equal to all other losses due to small grates. The second important source of loss accompanying high rates of combustion is due to the high velocity of the gases in passing over the heating surface, not allowing the heat from them to be as fully absorbed as it should be.

Carefully measured tests show that spark losses under high rates of combustion are equal to 10 to 15 per cent. of the coal fired. Numerous experiments on the shop-testing plants and in road tests show how rapidly the amount of coal used per pound of water evaporated increases with high rates of combustion. In his paper on the Effect of High Rates of Combustion, Prof. Goss gives the results of his experiments with different areas of grates on the locomotive in the laboratory as follows: When coal is burned at the rate of 50 lbs. per square foot of grate per hour, 8 lbs. of water were evaporated per pound of coal; at 100 lbs. the rate was 7 lbs. of water, and at 180 lbs. only 5 lbs. of water. In the tests of compound

locomotives on the C. M. & St. P. Ry., reported to the Master Mechanics' Association in 1892, we find that with Braceville coal, when the rate of combustion was 109 lbs., the rate of evaporation was 6 lbs., but when the former was increased to 156 lbs. the rate of evaporation fell to 5 lbs. Also, with Pittsburgh coal, with same series of experiments, when the rate of combustion was 80 lbs. the rate of evaporation was 7.7 lbs. of water, but when the former was raised to 100 lbs. the water rate was decreased to 6.7 lbs., a difference of one pound in the water rate in each case, due to a change in the coal rate. Tests on the C., B. & Q. R. R., with Streater coal, when the coal and water were carefully measured, showed with a coal rate of 90 lbs. per square foot of grate per hour a water rate of 7 lbs., but when the coal rate was 125 lbs. the water rate fell to 6 lbs., a difference of one pound less water evaporation, caused by a difference in the rate of combustion of 35 lbs. per square foot of grate.

It has been claimed that, even with rates of combustion as high as 200 or 225 lbs. coal per square foot of grate per hour, the combustion is complete and almost perfect, and in fact the analysis of the smokebox gases in the Purdue experiments showed this to be true, as there was hardly a trace of carbonic oxide and free oxygen was present. For this reason it is argued that the loss of economy due to high rates of combustion is not the result of a small grate, but is due to imperfect absorption of heat by insufficient heating surface, as is evident from the increase in temperature of the smokebox under such conditions. In Prof. Goss's experiment the heating surface was constant and the total amount of coal burned per hour was also constant, the only change being the area of the grate. The loss in economy must therefore be attributed to the reduction of grate area, even if it resulted in a failure of the heating surface to absorb a proper amount of heat due to the high velocity of the hot gases through the tubes. In the above experiments the vacuum in the smokebox when burning 61 lbs. of coal per square foot of grate was 2.2 inches of water, and when burning 240 lbs. coal per square foot it was 5.6 inches, the draft in the latter case being two and a half times as great as in the former, and the velocity of the gases through the tubes must have been correspondingly increased. If the small grate requires such a strong draft that the gases are in contact with the heating surface too short a period, it must result in a loss in economy. The heating surface in a locomotive can never be too great for it is not possible to obtain the amount necessary for maximum economy on account of the large size and weight of the boiler.

In stationary boilers good practice requires $1\frac{1}{5}$ sq. ft. grate and 10 sq. ft. heating surface for 1 horse power, and for the 1,000 horse power developed by modern locomotives, there would be required on the same basis 200 sq. ft. of grate surface and 10,000 sq. ft. of heating surface. The problem then is with all the available heating surface possible in a locomotive, what is the proper grate area for a given steam or coal consumption? Cannot the proportion of grates for locomotives be placed on a rational basis, having reference to the cylinder volume and the speed per mile? At present the general practice is to make the firebox for a bituminous coal burning locomotive 40 or 42 in. wide, and 9 or 10 ft. long, regardless of the size of the cylinders, the diameter of the wheels, or the speed, in miles per hour.

In making the grate area proportional to the cylinder volume, the dimension in the direction of length is limited to about 10 ft., on account of the difficulty of firing on a longer grate. In order to obtain larger grate areas it is therefore necessary to increase the width, and there seems to be no good reason why the width of fireboxes should be either 42 in. or 96 in., which is now the prevailing practice, but it certainly should be as much greater than 42 in. as is necessary to secure a moderate rate of combustion, corresponding to 80 or 90 lbs. of coal per square foot of grate per hour.

The locomotives with 19x26 inch cylinders, built 15 years ago, had grates 42 in. wide and 9 ft. long, and the amount of coal

required to supply these cylinders with steam was sufficient to require a strong blast, drawing sparks through the tubes and out of the stack. The grate proportions in this case cannot therefore be said to be too large. The total volume of the two cylinders is 7.87 and the grate area 31.5 sq. ft. and the ratio of cylinder volume to grate area is as 1 to 4. We regard this as a good proportion, and believe that when it is made less that the rate of evaporation is reduced. In the Master Mechanics' Committee report on Ratios of Grate Area to Cylinder Volume, read at the convention in June, 1897, the committee recommend that this ratio should not be less than 3 for simple passenger or freight locomotives. It will be found, however, that in all recent freight locomotives the ratio is less than 3, and it is evidently due to the indisposition of locomotive builders to give up an old and irrational practice of making fireboxes as wide as the frames, and no wider.

In the report referred to, the proper method of calculating grate area for locomotives, based upon the cylinder volume, is clearly explained, and we will give briefly a sufficient portion to show its application. It is assumed that the average work in the cylinder is done at one-fourth cut-off and the average speed is one-half the diameter of drivers for passenger engines, or 168 revolutions per minute, and for freight engines one-third cut-off and 120 revolutions is assumed. Then if V = volume of both cylinders in cubic feet, the water per hour, from and at 212° F., will be approximately $2150 \times V$ for either passenger or freight engines. The coal consumption will depend on its quality, and for western bituminous coal, 6 lbs. water per pound of coal may be taken as a fair average, and if the rate of combustion is not to exceed 90 lbs. per square foot of grate per hour, then the proper grate area will be, in terms of cylinder volume,

$$\frac{2150}{6 \times 90} \times V = 4 V. \text{ That is, the ratio of grate area to cylinder}$$

volume under the above conditions should be 4. Let us see how this compares with the ratios found for some of the large freight locomotives recently built:

The 12-wheel engine for the Illinois Central, illustrated in the October number of this paper, has cylinders 23x30 inches, and a grate 42 in. wide and 11 ft. long, having an area of 37.5 sq. ft. The cubic contents of both cylinders is 14.4 cu. ft., and 37.5

$\frac{37.5}{14.4} = 2.6$. If the grate was made as large as would be required

by a factor of 4 times the cylinder volume it would be $14.4 \times 4 = 57.6$ sq. ft., and if made 11 ft. long, the width should be about 62 in. The P. R. R. Class H6 freight engines, illustrated in the June, 1899, number, have cylinders 22x28 inches, and grates 40 inches wide and 10 ft. long, giving an area of

33.3 sq. ft. The cylinder volume is 12.32 and $\frac{33.3}{12.32} = 2.7$. If

the grate for these engines was made 4 times the cylinder volume, its area would be 49 sq. ft., and if 10 ft. long, its width would be 53.8 inches. As an example of a recent large passenger engine we will take the 10-wheel engine for the Denver & Rio Grande, illustrated in September, 1899, number. This engine has cylinders 21x26 inches, and grate area 33.5 sq. ft. The

total cylinder volume is 10.4 and $\frac{33.5}{10.4} = 3.22$, and according to

the proportion we suggest the width should be 50 in., instead of 41 in.

Freight engines having driving wheels of small diameter present no difficulties in extending the firebox over the wheels. Wide fireboxes extending over the large drivers of passenger engines raise the center of the boiler rather high, but the Atlantic type is admirably adapted to the use of large wheels and wide fireboxes which do not extend over the drivers but over the trailing wheels. In either freight or passenger locomotives it is easily possible to use wider fireboxes without resorting to radical changes in the wheel arrangement or to material modifications of existing general plans.

AN AMERICAN OBSERVER ABROAD.*

II.

A Day at Horwich.

By Professor W. F. M. Goss.

The Lancashire and Yorkshire Railway centers in the city of Manchester, from which point it reaches out to the north, east and west, covering the adjacent country with a complicated network of track and embracing such cities as Liverpool, Preston, Leeds and Bradford. The trip by local train from Manchester to Horwich gives one an hour's ride among green hills, bushless and treeless, but of magnificent proportions, marked here and there by the derricks of busy coal mines. In the very midst of such hills is Horwich. Twelve years ago, or thereabouts, the Lancashire and Yorkshire Railway selected this place as the location of its general shops, and to-day employment is given to 4,000 men—a result accomplished under the immediate direction of Mr. J. A. F. Aspinall, until recently Chief Mechanical Engineer of the road.

Mr. Aspinall needs no introduction to readers of the "American Engineer," for some have gained personal acquaintance with him in the course of his repeated visits to America, and others have come to know him through his most valuable contributions to technical literature. At the time of my visit Mr. Aspinall was still Chief Mechanical Engineer, but the announcement of his promotion to be General Manager was made a few weeks later.

The shops at Horwich make all heavy repairs on 1,400 locomotives, build new ones and supply heavy forgings, all castings and all machine work needed by other departments of the road. The works include a steel mill in which steel wheel-centers are cast, tires are rolled, and lighter work in great variety is turned out. Dynamos for station lighting, electric signaling apparatus, telegraph instruments and many other articles which American railways obtain from outside sources are in the case of this road made at Horwich. The variety of processes undertaken requires space and organization, and both of these are had. The shops consist of three long parallel buildings, having tracks between them, and in some cases within them. (See Mr. William Forsyth's description of these shops, June, 1898, page 194.—Editor.) The locomotive repair shop occupies one portion of one of these buildings, and new locomotive work another portion, the two portions, while separated only by a transfer table running across the shop, being quite distinct. The steel mill is a complete establishment by itself, and the electrical department is a factory seemingly as independent of other things in its vicinity as though it were in another city.

Mr. Aspinall has succeeded in securing a high degree of uniformity in his motive power. With 1,400 locomotives he has but three different types, though the first installment of a fourth type is just now being put into service. The three types which at the time of my visit were doing the business of the road are:

- (1) A freight engine having six coupled wheels 61 inches in diameter;
- (2) A tank engine having four coupled wheels 68 inches in diameter, and two 2-wheel trucks, one leading and the other following the drivers; and
- (3) An express passenger engine having four coupled wheels 87 inches in diameter, and a 4-wheeled truck leading the coupled wheels.

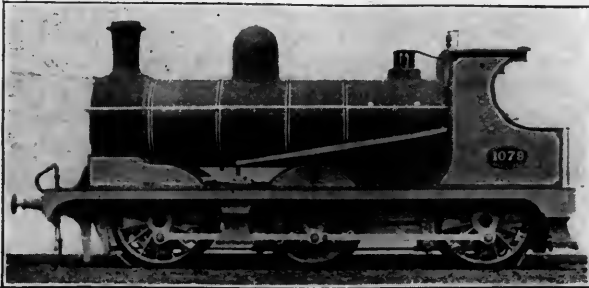
The engines weigh 68, 59 and 68 tons respectively. All have cylinders of the same size (18x26 inches) and the tank engine and the passenger engine have boilers which are identical. Moreover, the boilers of all the engines have 50-inch shells, 200 tubes $1\frac{1}{4}$ inches in diameter, and a firebox of standard dimensions.

All engines have plate frames and are inside connected. Joy

* For previous article see October issue, page 313.

valve gear is exclusively used and its details are so well designed as to give a very stiff arrangement.

It was at Horwich that I first saw the parts of an English engine, both before and during the process of erection. Very little machine work goes into the frame. Plates for the sides, an inch in thickness, two or three feet in width, and thirty feet, or so, in length, are piled and milled to bring the edges to



Lancashire & Yorkshire Standard Locomotives.
Six-Coupled, Freight.

proper outline. When thus reduced to the desired form, two plates are set up to form the sides, the cross-bracing is riveted in, castings to give bearing for the axle-box wedges are added, and the frame is practically done.

The front of the boiler is supported from the frame and not by the cylinders, as in American practice. The latter are slipped up between the frames and are bolted to the side-plates; while easily removable, they have a very secure place provided for them, and they certainly have the appearance of being well protected and quite warm as they nestle close together. The exhaust passages are so direct that by looking into the exhaust tip one may see the slide valve. I was told that an engine coming in with broken cylinders could have the old pair removed and a new pair applied, ready for the road again, in four hours from the time of its arrival in the shop.

With the inside connection, the coupling-rod pin on the outside of the main driver is put opposite the inside crank, the wheel crank pin and coupling rod thus serving in part to balance the axle crank and the main rod. A light counterweight in the rim of the main driver is, however, necessary, and while entirely correct, it looks odd at first sight to see the wheel going with the crank and counterbalance on the same side of the center.

But I imagine that the inside-coupled engine, though it has many good points, will not always live even in England, for here, as in America, one manifestation of progress in railroad-



Lancashire & Yorkshire Standard Locomotives.
Local Passenger and Freight.

ing is a desire for more powerful locomotives. A response must involve larger cylinder volumes, and as no considerable increase over present maximum dimensions is possible under existing practice, the cylinders will in the end come outside of the frames.

Mr. Aspinall forges his crank axles in a very ingenious

manner. The forging, properly speaking, begins with a blank of uniform section, which for an 8-inch axle carrying cranks for 26-inch stroke, would, I judge, be about $8\frac{1}{2}$ inches thick, 20 inches wide and 5 feet or more long. The forging consists in cutting the required axle out of the solid material of such a blank, the cranks are cut, lying in the same plane and together. The process begins with eight cuts by the hot saw partially across the blank—four being made from one edge and four from the other. These outline the webs of the cranks. From the saw the blank goes to the steam hammer, where the blocks between the several webs and between the outside webs and the ends of the axle, are chiseled out, and I presume that this operation is followed by some hammering to round up the wrist pins and the body of the axle, but I did not see this done. Finally the middle portion of the axle is twisted to bring the two cranks at right angles. This finishes the forging. The blank from which the axle is cut weighs three times as much as the finished piece, but no considerable loss results, since the material cut away is in the form of large blocks and serves as stock from which smaller forgings are made.

The axle blanks are shaped up preparatory to the forging, by means of a hammer of the battering-ram type. It consists of two immense masses of iron carrying suitable dies, and mounted on a horizontal bed-plate, upon which they are made to travel by suitable steam-driven mechanism. In preparation for a blow the masses separate, and returning they impinge simultaneously on opposite sides of the work interposed between them. The machine is from an old design, a similar hammer having been installed at Crewe very many years ago, where it is now referred to as a "Ramsbottom horizontal duplex ham-



Lancashire & Yorkshire Standard Locomotives
Express Passenger.

mer." The Horwich machine is rated at 35 tons, a value which, I presume, represents the weight of each of the two masses. It is apparent that such a hammer, while requiring no heavy foundation, gives a blow which, because of the weight and slow motion of the masses, is most efficacious in its effect on hot metal. But it is not adapted to general forging, its best work being on sections of plain outline.

The labor cost of finishing a crank axle from the forging at Horwich is but \$15. From an officer of another road purchasing axle forgings, and probably having lighter machines upon which to finish them, I learned that when axles are bought rough from the forge the labor cost for finishing is about \$25, but when purchased rough-turned, the piece-work price for finishing is from \$9.25 to \$10, depending on the size of the axle. I may add that failures of crank axles are of rare occurrence. I was told by a chief of motive power having 1,600 axles in service, that he had had but three failures in eight years, two having been detected when the engines were in the shop, and the third having occurred on an engine engaged in yard work.

I have already stated that Mr. Aspinall was at the time of my visit in the process of adding to his equipment a fourth type of engine. This is for heavy passenger service. As compared with those already described it presents differences quite similar in character with those which mark recent changes in American practice. Thus, while the volume of cylinders has been increased somewhat, the most significant change is

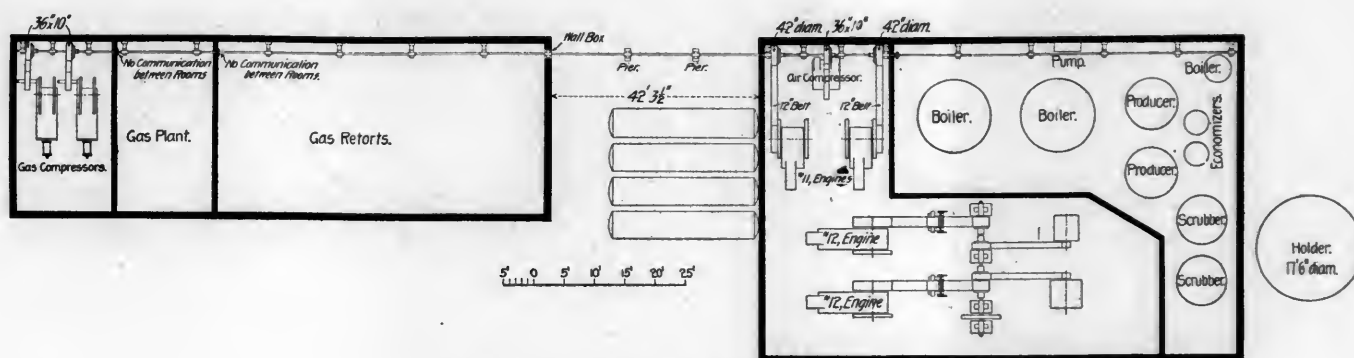


Fig. 1.—General Plan of the Entire Plant.

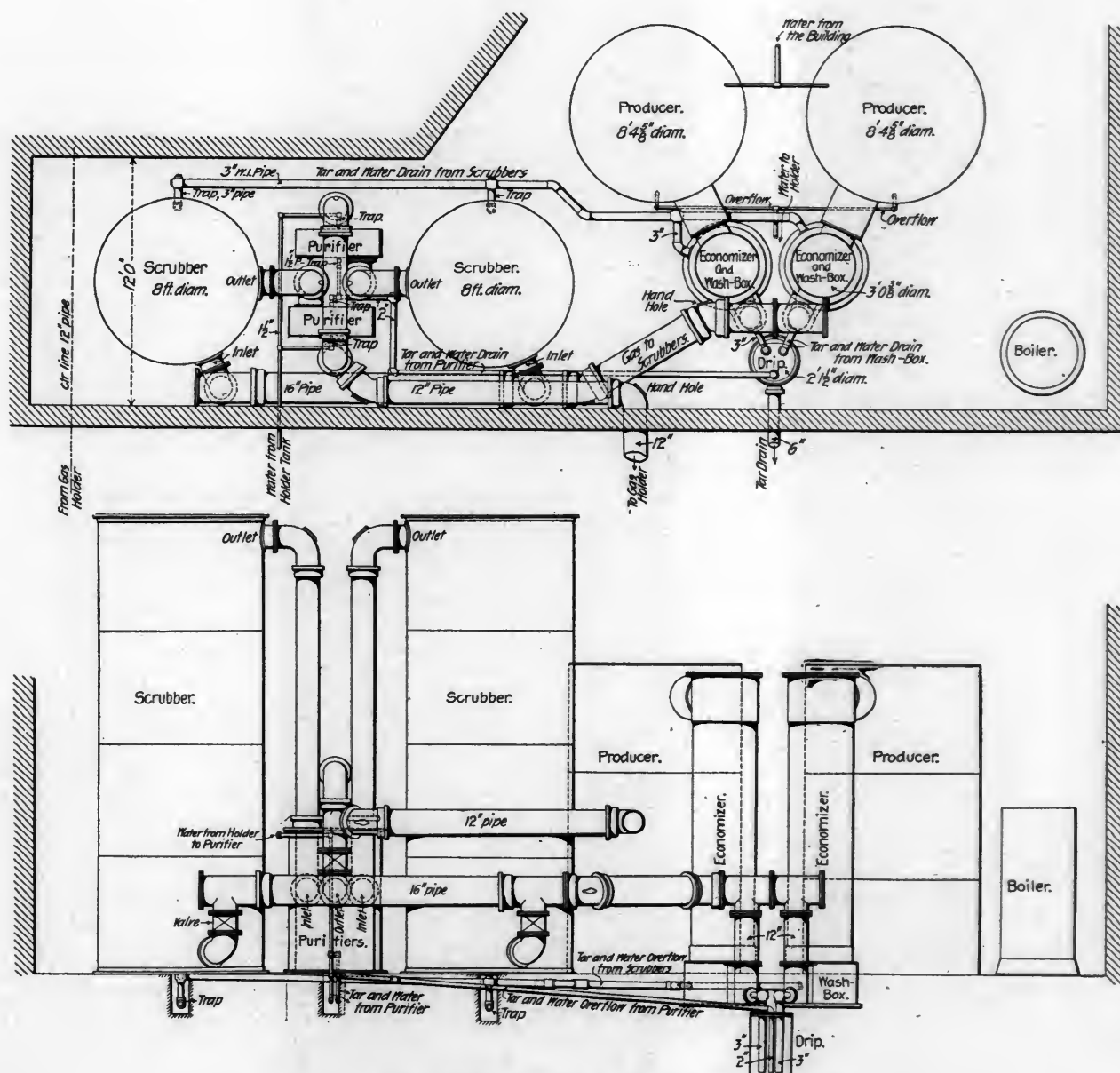


Fig. 2.—Plan and Side Elevation of the Taylor Gas Producers.
GAS ENGINES AND PRODUCER GAS.
JERSEY CITY TERMINAL, ERIE R. R.

use of modern high class boilers and steam engines, with a view of burning fine anthracite instead of the very expensive lump coal formerly used, it was decided to put up an entirely new power plant, using gas engines driven by producer gas made from the very cheap grades of fine anthracite available along the line of the road, and to install two steam boilers to be used exclusively for heating purposes in the winter and to be shut down entirely during warm weather. The estimated saving was large and the total cost of such a plant was less than that of an equivalent steam plant. The plan decided upon included two 400-horse-power vertical boilers of the Morrin, Climax type, Taylor gas producers of sufficient capacity for 400 indicated horse-power in gas engines, two 90-horse-power and two 45-horse-power Otto gas engines, an Ingersoll-Sergeant duplex air compressor, belt driven, a 130-2,000-candle-power arc light machine, a 450 light incandescent machine and the necessary accessories. The whole plant is arranged in duplicate, and in addition to the power used at the terminal station the producer gas is piped about 1,200 feet to the locomotive coal chutes and ash handling plant, also operated by Otto gas engines. The connecting main is not yet completed and the coal and ash handling plant is now oper-

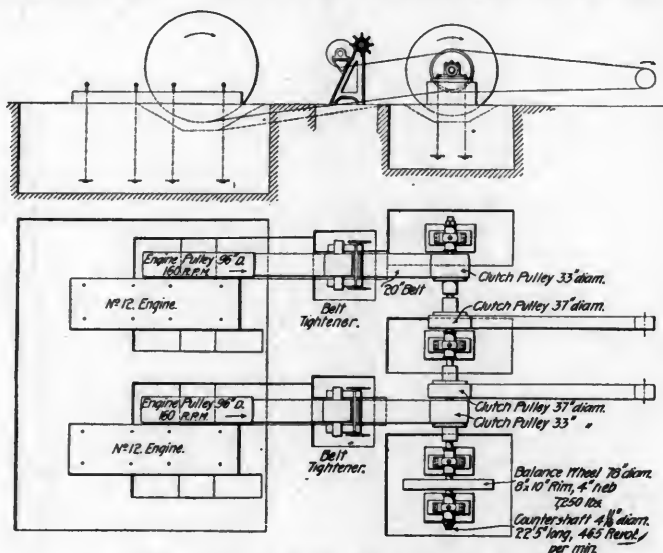


Fig. 4.—Plan of Large Engine Foundations.

ated by city gas, the cost of which is about three times that of the producer gas.

The decision to adopt gas engines was influenced by the very favorable guarantees offered by the builders of the gas producers and the gas engines. The guarantee of the producers by Messrs. R. D. Wood & Co. of Philadelphia called for 80 cubic feet of gas having 125 B. T. U. per cubic foot from each pound of anthracite buckwheat coal of fair quality, this being equivalent to 10,000 B. T. U. per pound of coal, which is equivalent to an efficiency of production of 80 per cent. The Otto engines were to produce an indicated horse-power hour with a consumption of not more than $11\frac{1}{4}$ pounds of good anthracite buckwheat at full load. The producers were afterward given the advantage of an important improvement which enabled them to surpass the guarantee. The coal used is rice size, which is almost refuse. The gas engines produce an indicated horse-power per hour with the consumption of about 12,000 heat units, which gives about 22 per cent. thermal efficiency.

We understand that the Otto Gas Engine Works were responsible for the engines and the general details. The general arrangement of the plant, the location of the producers, boilers, gas engines and compressors for air and Pintsch gas may be seen in the engravings. The Pintsch gas plant was built several years ago and the power plant was provided for in a new building adjoining. The entire plant is on "made land," which required piling foundations throughout, including the building. The arrangement and plan of the gas plant, producers, scrub-

bers and purifiers were in the hands of R. D. Wood & Co. of Philadelphia.

The plan of the entire installation is shown in Fig. 1, in which the relative location of the producers, gas holder, boilers, gas engines, air compressor and gas compressors are given. The producers are shown in plan and side elevation in Fig. 2, and in end elevation in Fig. 3. Fig. 4 illustrates the belting connections of the two large engines, and the general drawing, Fig. 1, gives the corresponding information as to the small engines.

The Gas Engines.

The engines are of two sizes, known as Nos. 12 and No. 11, guaranteed to give 90 and 45 actual horse-power each with producer gas having 125 heat units per cubic foot. The exhaust is led to vessels on the ground outside of the building, from which pipes run to the roof. Clutches are provided for all the engines so that one or both of each size may be used. The gas compressors, which are of the Pintsch type, were changed from direct steam to belt driving. This work was done in a novel way. The compressors run almost continuously, one running 20 and the other 24 hours per day, which necessitated quick work in making the change of power. The pedestal holding the pinion shaft, carrying the belt pulley, was secured to the main frame of the compressor in the exact location where the steam cylinders were bolted.

The large No. 12 twin cylinder gas engines are illustrated in Fig. 5, the smaller ones, No. 11, are shown in Fig. 6, and a still smaller size, No. 8, one of which is used at the locomotive coaling station, is shown in Fig. 7. The large engines, which are known as the "Columbian" type, each develop 106 actual horse-power and 139 indicated horse-power. These engines are belted to the line shaft, from which two generators are driven, one for arc and the other for incandescent lights. There are two cylinders, one above the other, working on the same crank pin, and giving an impulse at every revolution. This type of engine gives a very steady motion, as may be seen by watching the lights. The amount of gas is in direct proportion to the power and is regulated by the governor. These builders make a specialty of horizontal engines running at slow speeds to avoid excessive wear. The parts are easily accessible without dismantling the whole engine. The lubrication is by automatic sight feed lubricators on all bearings and on the cylinders. The gas, air and exhaust valves are all placed in separate castings easily removable and provided with water channels for cooling.

The No. 11 engines, Fig. 6, develop 50 actual and 60 indicated horse-power each. They are belted directly to the long line shaft driving the Pintsch gas compressor, the coal elevator for the producers and, as shown in Fig. 1, the air compressor. This compressor, made by the Ingersoll-Sergeant Co., is placed near the engines. It has a capacity of 380 cubic feet of free air per minute against a pressure of 100 pounds per square inch. The air is used for brake testing and cleaning cars in the yards. The No. 8 engine, Fig. 7, develops 38 actual and 42 indicated horse-power. One of this size and one of No. 6, which will develop 19 actual and 21 indicated horse-power, are used at the coal and ash hoist. A No. 6 engine is also used at one of the repair shops of this road. Fig. 7 shows the appearance of several of the smaller sizes of engines built by this concern.

The Otto gas engine is too well known to require a description. It is sufficient to say that the valves are of the poppet type. The ignition is electric, in this case storage cells being used, which are charged by the dynamo circuits, making a reliable and thoroughly satisfactory arrangement. The governor not only regulates the speed and gas consumption but it cuts off the gas supply in case the engine stops for any unforeseen reason, preventing the escape of gas from the engines. It also permits of changing the speed without stopping the engine. It is interesting to watch the No. 11 engines running the air and gas compressors. The load is very variable be-

cause the air compressor, which takes about 50 horse-power, is thrown on or off suddenly by the automatic regulator, and yet the speed is so uniform as to appear to be perfectly steady. Salt water is pumped from the river to cool the cylinders of the gas engines and the air compressor in warm weather, and in the winter, while the steam heating boilers are needed, fresh water will be used and the heated water will be fed into the boilers by the feed pumps. This method avoids the use of city water in summer.

The Taylor Gas Producer.

The gas producers are of the Taylor automatic type, with economizers, furnished and installed by Messrs. R. D. Wood & Co. of Philadelphia. The essentials of a gas producer are complete combustion of its carbon, uniformity in quality of gas, ease and continuity of operation. The operation consists of combustion of the coal within an atmosphere containing insufficient oxygen to completely burn it. For a successful producer the conditions may be summarized as follows:

1. A deep fuel bed carried on a deep bed of ashes; the first to make good gas and the second to prevent waste of fuel.
2. Blast carried by a conduit through the ashes to the incandescent fuel.

It may be said that the settling is more from the walls to the center. There is nothing to burn out, for the top of the iron work is six inches below the fire, and the lower part of the producer is nearly cold. There is nothing to wear out, for all the parts are heavy castings, and in ordinary working the table revolves only three or four times in a day.

Details of the Producer Plant.

The producers as well as the engines are in duplicate. They are 7 feet in diameter by 15 feet high, and are fitted with a bucket fuel elevator and Bildt automatic feeders. The gas passes from the producers into the vertical economizers, where it is cooled by giving most of its heat to warm the blast of air used in making more gas. The air draft is produced by a Korting steam blower, the steam being supplied by the small upright boiler in the corner of the house. In summer this is the only steam required about the plant. The gas enters at the top of the economizer and passes out through a wash box below. The air is drawn up from the bottom of the economizer, passing out near the top, where the hot gas enters. The wash box removes a large part of the tar and acts as a seal to prevent the gas in the holder from passing back into the producer. From the

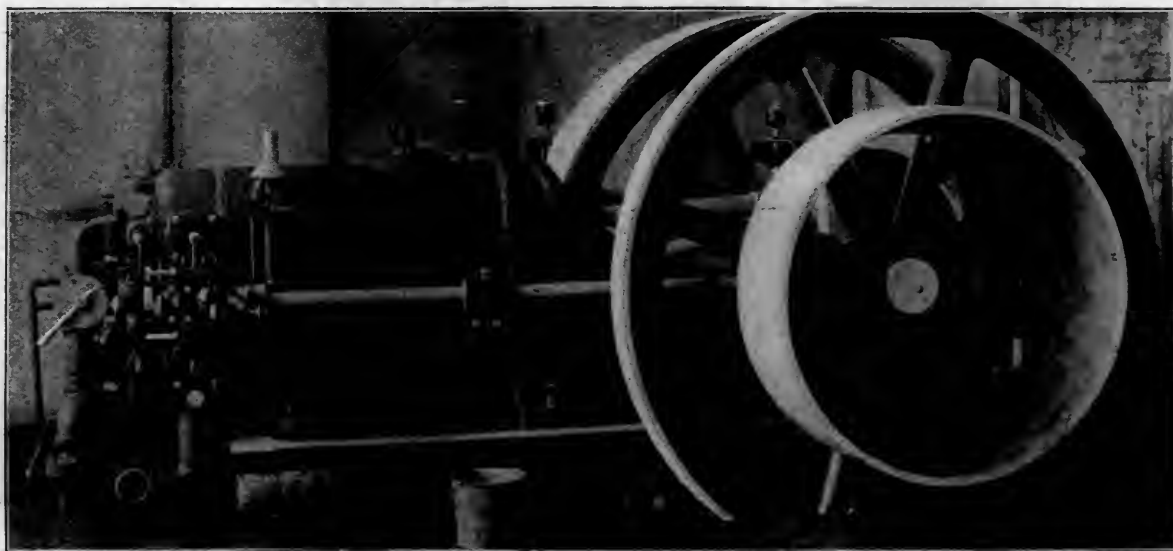


Fig. 5.—One of the Large Otto Gas Engines No. 12.
THE OTTO GAS ENGINE WORKS, PHILADELPHIA, PA.

3. Visibility of the ashes, and accessibility of the apertures for their removal, arranged so that operator can see what he is doing.

4. Level, grateless support for the burden, insuring uniform depth of fuel at all points and consequent uniformity in the production of gas.

In this producer, shown in Fig. 9, there is no grate to waste coal through, and there is practically no waste in cleaning. The deep ash bed permits the coal to burn up clean, and in practice the carbon is frequently gasified so that less than one-half of one per cent. of the original carbon remains in the coal. Any clinkers that will pass through a six-inch space will be discharged from the producer in regular grinding without any manipulation or waste of fuel, and this distance may be increased if desired. Cleaning is done without stopping the producer for a moment and the quality of the gas is only slightly injured for a short time, hence the producer is practically continuous, and at the same time it is just as perfect an apparatus when used intermittently. By the use of the test or sight holes in the walls, the attendant always knows when to grind down his ashes and when to stop. In grinding down the ashes the settling of the fuel is active next to the walls or

wash box the gas passes to the base of the large vertical scrubber, which is of the character usually found in gas works. Its compartments are filled with coke wet by sprays of water. The purpose of the scrubber is to remove ammonia, and most of the tar and sulphur from the gas. The remainder of the tar is removed in the purifier, a rectangular box filled with specially prepared material; this also removes more of the sulphur. The purification is not complete, but the gas is clean enough for use in the engines when it leaves the purifier and passes into the gas holder for storage until it is drawn through the main to the engines. The gas holder is 18 feet in diameter by 12 feet deep, floating in a steel tank 19 feet 6 inches in diameter by 12 feet deep. It stores a supply of gas sufficient for about ten minutes running and serves to balance irregularities in the consumption and mixture of the gas. A drip pot receives all the tar drained from the producer plant and discharges the surplus automatically into the sewer. Water is carried from the tops of the producers into the gas holder tank in winter to prevent freezing. The coal is elevated from the ground, where it is delivered by hopper cars on a trestle, and is stored in a bin elevated about 30 feet, from which it runs by gravity into the automatic feed attachment, which dis-

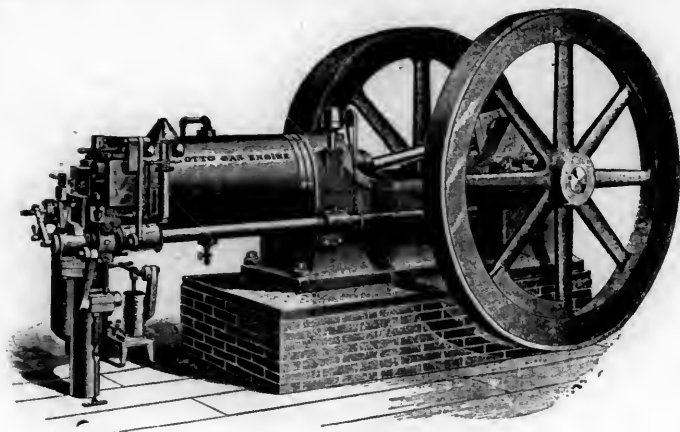


Fig. 6.—No. 11 Otto Gas Engine.

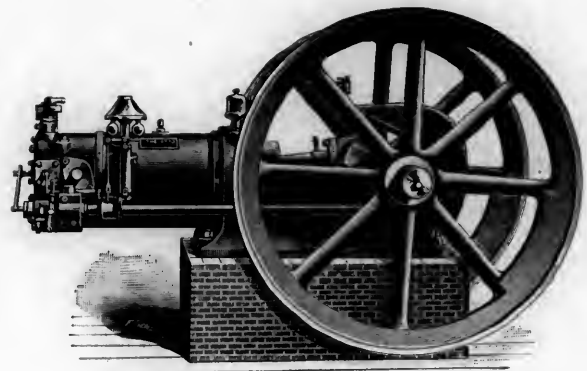


Fig. 7.—No. 8 Otto Gas Engine.



Fig. 8.—One of the Indicator Cards Taken in the Test.

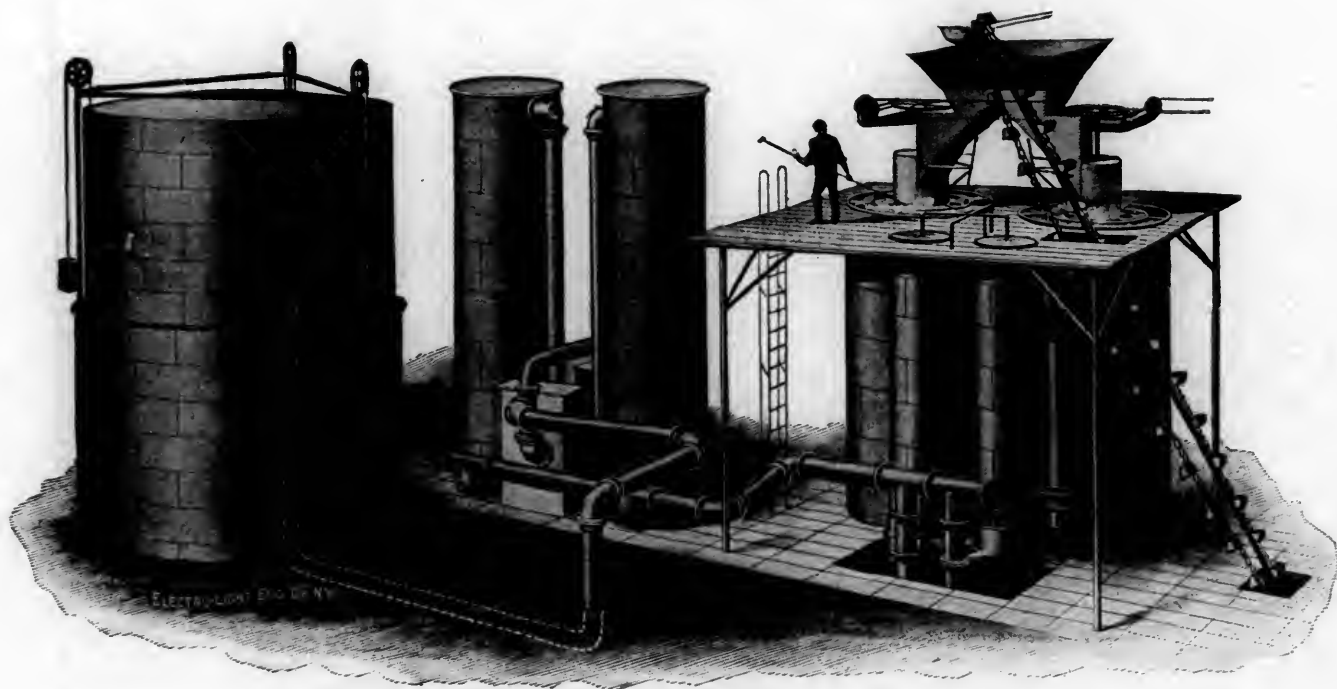


Fig. 9.—Taylor Gas Producers, with Economizers, Purifiers and Scrubbers.

R. D. WOOD & Co., PHILADELPHIA, PA.

tributes it continuously and uniformly over the gas producing surface.

Tests.

In a test made last June by the mechanical department of the road the following figures were taken from one of the large engines:

Cylinder	14½ by 25 inches.
Revolutions per minute.....	176
Duration of test	30 minutes.
Cubic feet of gas total	2,417.5
Pressure of gas.....	2½ inches.
Average horse-power during tests (one cylinder).....	52.2
Average horse-power of engine	104.4
Cubic feet gas per horse-power hour	92.6

One of the indicator cards is reproduced in Fig. 8. This was

taken at 170 revolutions per minute, giving 54.5 pounds mean effective pressure and 49.16 horse-power. The gas, when analyzed by the builders of the producers, gave the following results:

Carbonic acid.....	8.6
Oxygen.....	0.4
Carbonic oxide.....	17.2
Hydrogen	18.3
Marsh gas	2.4
Nitrogen (by difference).....	53.1
Caloric power per cubic foot.....	136.3 B. T. U.

In another analysis the gas was found to have 142.9 B. T. U. per cubic foot, and as the engine used 92.6 cubic feet per horse-powers hour the engine developed one horse-power hour on

13,235 B. T. U. and one horse-power hour on a consumption of 1.03 pounds of coal. The analysis of the coal is as follows:

Moisture	1.62 percent.
Volatile matter....	7.50 "
Fixed carbon	78.32 "
Ash	12.56 "

About 93 per cent. of the coal is used to generate the gas, the remaining 7 per cent. being required for raising the steam. The tests showed that 84.7 cubic feet of gas were made per pound of coal, having 142.9 B. T. U. per cubic foot or 12,102 B. T. U. per pound of coal, while the guarantee called for 80 cubic feet at 125 B. T. U., or 10,000 B. T. U. per pound. The engines were guaranteed to give a horse-power hour on 1.25 pounds of coal. They actually gave this on 1.03 pounds. The figures show that both the engines and the producers more than fulfilled the promises. The producers proved to have a capacity for 471.4 horse-power instead of 400.

Operation.

One man looks after the producers. Another with a helper tends the engines and the electric machinery. There is no difficulty in starting the engines; hand pumps are provided, but compressed air, being available, will be used for this purpose. If anyone is doubtful about the reliability of gas engines used under these conditions he should visit the plant and note the regularity and smoothness of its operation, which appears to justify the same amount of confidence imposed in the best possible steam engine installation.

The Future of the Gas Producer.

This plant is important because it gives an insight into the possibilities of cheap power when the lower grades of anthracite coal are available. Producers have made little progress in this country, though they are used more generally abroad. It seems clear that power may be produced in this way for less than half the cost of steam and with no greater outlay for plant. Power, however, is not the only use to be made of producer gas. Furnaces may be fired with it and it may be burned under steam boilers. Even where steam is required for heating, this system offers advantages in that the producers require very little attention and the same gas may be used for engines and for boilers. The coal may all be handled at one place and the gas sent to any reasonable distance for distribution to engines scattered over a large plant. With proper gas storage facilities the producer plant need not be large enough to keep up with the demand in the day time and the distribution of power in such a case as the one described seems to have important advantages not possessed by any other system. The progressiveness of the officers of the Erie Railroad is to be commended in this connection and there seems to be no reason to expect anything but a continuance of the good results which are now being obtained.

We acknowledge indebtedness to Messrs. H. F. Baldwin, Engineer of Maintenance of Way, and A. E. Mitchell, Superintendent of Motive Power of the Erie Railroad, and to the officers of the Otto Gas Engine Works and R. D. Wood & Co. for information and facilities used in the preparation of this description.

The Chicago elevated roads carried a very large number of people "Chicago Day," October 9, and probably exceeded all of their previous records. The totals on the various roads were as follows: Metropolitan, 186,390; South Side (Alley L), 169,987; Lake Street, 85,438, a total of 441,815. From 9 to 11 p. m., were the rush hours, during which time the crowds went home after the evening parade. From 9 to 10 more than one train per minute averaging 5 cars per train was handled over the downtown loop which is used jointly by all of the elevated roads. In 17 hours, from 7 a. m. to midnight, 1,002 trains with a total of 4,702 cars, were handled over the loop, which means one train nearly every minute during this time. This enormous traffic was handled with no delays and no accidents and the test speaks well for the "loop" principle in elevated railroads.

INTERESTING FACTS CONCERNING THE WESTINGHOUSE GAS ENGINE.

A few years ago there were thought to be difficulties in the way of using gas engines of more than about 100 horse-power and it was generally predicted that this type could not be considered a competitor of steam for this reason. The Westinghouse engine has proved that this opinion was entirely wrong and there is now a good prospect of building very large gas engines. The Westinghouse engine was at first confined to small powers and the idea of building one of 225 horse-power was considered at least a doubtful experiment. This size has now become popular and a 650-horse-power, three-cylinder gas engine of this type has been running in the works of the Westinghouse Electric & Manufacturing Company for over a year with perfectly satisfactory results. This, however, is not the limit of size, for a 1,500-horse-power engine, with three cylinders 34 by 60 inches, for direct connection to an electric generator, is now under way. The patterns are all finished and the castings are being made. This engine will be 44 feet long over the generator, 12 feet 4 inches wide over the bed plate and 27 feet high. It will have a 19-foot fly wheel, will run at a speed of 100 revolutions per minute and will develop 1,500 brake horse-power. This is much larger than a steam engine of equal power because it is single acting and has only half as many impulses as a single-acting steam engine, although the initial pressure is about 400 pounds per square inch. The Westinghouse gas engines are rated in terms of brake horse-power because these builders do not consider the indicator a satisfactory device for measuring power when the pressures are so suddenly applied, and for the further reason that a conservative rating is specially desired in order to insure a surplus of power to meet requirements in emergencies.

With natural gas having 1,000 British thermal units per cubic foot these engines give a horse-power hour on a consumption of about 12 cubic feet, and often less, down to about 9 cubic feet. Varying the load of course affects the efficiency because of the relatively high internal friction of this type of engine. The friction does not change materially with the load and the loss becomes a larger proportion of the power as the load decreases. At half load of some of the engines tested the consumption of gas was increased about one-third. The compression in these engines is to about five atmospheres. The temperature of the exhaust is probably about 600 degrees F. It is not high enough to heat the exhaust to the point of redness visible in the dark, but it must be near that point. The water in the cooling jackets is generally kept down to a temperature below 212 degrees. It may be hot enough to evaporate, but this is not considered advisable because of the deposit of scale which would be formed. About four gallons of water per horse-power hour is generally used through the jackets when there is no evaporation. Noise of the exhaust, which has been troublesome with gas engines, has been "killed" by turning a little water into the exhaust pipe and by using exhaust pots, or mufflers, in series.

The question of lubrication of the cylinders and connecting rods in these engines has been disposed of very easily. The oil in the bottom of the crank case furnishes all the lubrication required inside the engine. The oil splashed up by the crank end of the connecting rod works up even to the top of the cylinder and past the piston in spite of the high pressures used. The oil is of high fire test, distilled down to the correct density, and is not made by mixing oils of different densities to secure the desired result. Experiments are now being made looking to the use of this engine with producer gas made from bituminous coal, but the results are not yet given out.

These facts were brought out in a discussion of a paper on the Westinghouse gas engine read by Mr. H. E. Longwell at a recent meeting of the junior members of the American Society of Mechanical Engineers.

BOX CAR ROOFS.

It may be possible to build box cars, and even large ones, so that they will not twist and vibrate under the stresses of service, but it is impracticable to build them so, because of the increase of weight which such construction would involve. Cars are well braced against vertical and fairly well braced against lateral stresses, but the nature of the roof framing is generally not such as to offer much resistance to bending and twisting. Greater strength may be given by means of diagonal rods placed in the roof, and by double boarding, but there seems to be nothing short of too heavy construction that will make the car really rigid. The roof certainly is not the place to stiffen the frame, and it may be accepted that cars must have a large amount of flexibility to which the roof must accommodate itself without leaking. This is clearly expressed in the following statement made before the Southern & South Western Railway Club two years ago:

"A car roof must be flexible, not in parts but as a whole; it must be covered with material as nearly indestructible as possible; nails must be dispensed with where possible; it must be secured in such a manner as to make it water tight, yet each and every part must be left free to adjust itself to the twisting, swinging, cambering or swaying of the car body."

The ideal car roof is one that will remain tight throughout the life of the car, and it should give equally good results in the low temperatures of northern winters, and the heat of the South in summer. It should be durable under the feet of the trainmen and should be protected from injury from the inside. These features were appreciated eleven years ago, as the following quotation from the proceedings of the M. C. B. Association shows:

"Your committee also expressed their opinion on what is needed to make a durable and substantial roof, that would not only last the lifetime of a car without continual repair, but would actually increase the lifetime by giving such protection as would prevent leakage and decay in all latitudes—a roof protected on the under side as well as on the top, and doing service as part of the car frame to stiffen and strengthen it. It is quite evident that the plastic type of roof (that is, the asphalt roof and other compositions) is fast coming into favor, and doubtless is the equal of the present types of metal roofs in use. Both systems, plastic and metal, have about equal footing, and neither can be ignored, even were your committee disposed so to act. Your committee would therefore recommend that boards (say seven-eighths inch thick and matched) be laid longitudinally, on the carlines, for the protection of the waterproof material on the under side, as well as adding stiffness and strength to the car frame; on this bottom lay the waterproof material—iron, asphalt or other composition."

A committee of the Central Railway Club last March confirmed the importance of inside protection. "We would recommend the laying of a course of sheathing on the under side of ceiling, lengthwise of car, as a protection against frequent punctures of the metal sheets when loading and unloading freight. The cost of such sheathing would amount to not over \$8 per car, and would save many times that amount in repairs and claims for damages to freight."

It seems possible to use metallic water-proofing material in such forms as to admit of the necessary flexibility, but a durable and flexible material that will not harden or crack and which may be secured without puncturing with nails seems to be the most promising practice yet taken up. A favorable argument for this form of roof is that an under sheathing is necessary. This does not add much expense or increase the weight to a serious extent and it does add to the strength of the car. Flexibility is necessary, and the best roof is that which provides this attribute in the most satisfactory way. The integrity of the roof becomes more important as the capacities of cars increase, and damage claims with leaky roofs will not be less than in the past with small cars. Present indications point to the plastic or torsion proof types as best meeting the necessities of the case.

NEW BALDWIN-WESTINGHOUSE MOTOR TRUCKS.

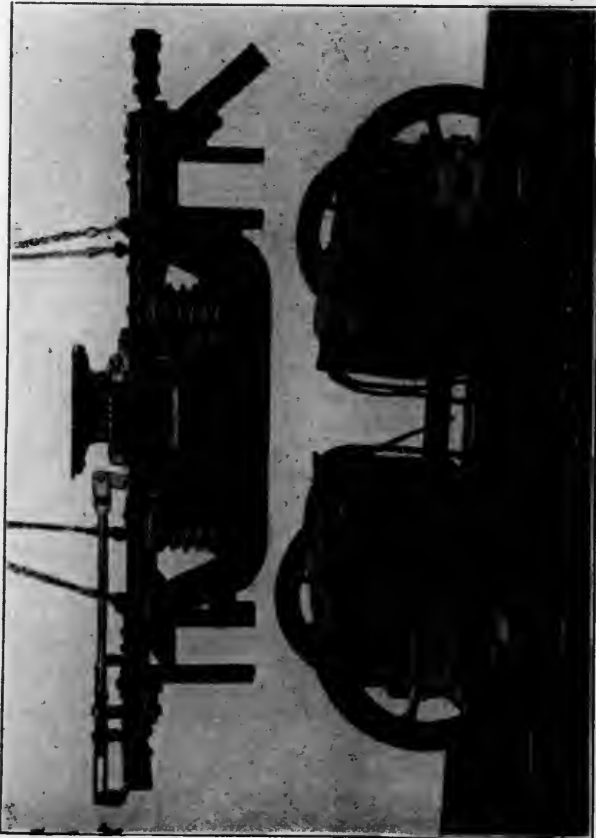
The accompanying engravings illustrate new motor trucks for elevated and suburban railroad equipment built by the Baldwin Locomotive Works and designed by Mr. George Gibbs, Consulting Engineer for these works and the Westinghouse Electric & Manufacturing Company. This design was made to meet the requirements of heavy train service, involving rapid acceleration and powerful application of the brakes, the design being in accordance with experience in the construction of car and locomotive trucks. The essential features of standard passenger car trucks have been combined with those of locomotives, in which tractive power stresses are provided for.

The motor suspension differs from the usual practice of hanging the motor frame to the truck transom, which involves the subjection of half of the weight of the motor and a large component of its torque upon the spring rigging. This method, by adding to the duty of the springs and requiring heavy, stiff springs, produces hard riding and has a tendency to tip the truck frame and cause the journal boxes to bind in the pedestals. The new design carries the weight of the motors on the axles and independently of the truck frame. The motors are carried in frames of their own, the end members of which act as equalizers and are supported by means of hangers and springs, which rest on cast steel seats formed upon the frames of the motors. The flexible jointing of the motor frame and its independence of the truck permit of easy riding of each motor upon its springs. The engravings show how the truck frame proper, to which the brake rigging is attached, may be lifted off entire, leaving the wheels and motors upon the track. To do this it is merely necessary to take out the pedestal cap bolts. The brake rigging is hung between the wheels and is of the fewest possible number of parts, without rods or levers over the motors. With this arrangement the tendency for the truck frames to tilt upon the application to the brakes is reduced, this being particularly desirable in the service for which these trucks are intended.

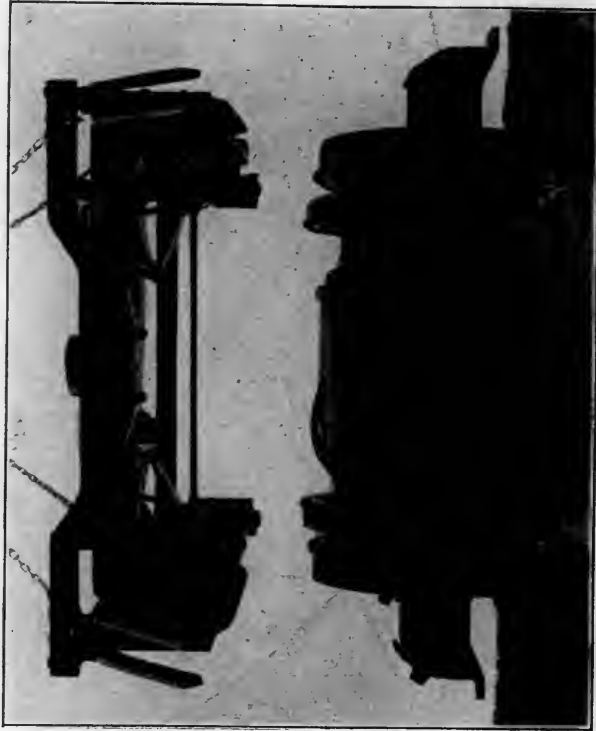
With a wheel base of six feet there is room enough to apply two 100-horse-power single reduction motors to these trucks. Wherever possible the weight of the parts has been kept down without sacrificing strength and wearing qualities. Renewable wearing surfaces are provided between the bolster and transom and the pedestals and transoms are lipped over the frames in order to cut down the shearing stresses on the bolts. The arrangement of springs is that which is in common use in passenger equipment. The equalizer springs are single coils, the bolster springs are double elliptic and the motor suspension springs have single coils. The transom is in the form of a light iron forging, similar to a locomotive truck, and made in one piece. It is lipped over the side frames and has chafing plates to receive the wear of the bolster. Cast iron driving boxes are used, with bronze bearings, similar to those used in engine trucks. The weight of the truck, not including motors but complete in other respects, is about 10,000 pounds.

These trucks are fitted with brake slack adjusters and they appear to be specially well adapted to the intended service. We consider the motor suspension, the accessibility, the strength and the way in which the truck frame may be removed from the other gear the most important features. There is every reason to expect that they will ride well, and it is evident that the designer has made very effective use of his experience in locomotive and car design.

In order to be able to meet the unprecedented demand for freight cars, the Pennsylvania Railroad has decided to order 2,000 more box cars, the contract to be placed with a Western concern. The statement is made by an official of the railroad company that within the past six months, 11,800 new cars have been ordered and put into service, and still the company is unable to take care of its patrons. The tonnage of the Pennsylvania already shows a 20 per cent. increase over that of the corresponding period of 1898.



Side View, with Truck Frame Lifted Off.



End View, with Truck Frame Lifted Off.



Perspective Views of Truck Complete.
 NEW BALDWIN-WESTINGHOUSE MOTOR TRUCK.
 Designed by MR. GEO. GIBBS, Consulting Engineer of the Baldwin and Westinghouse Companies.



Built by THE BALDWIN LOCOMOTIVE WORKS.

(Established 1832)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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Special Notice.—As the AMERICAN ENGINEER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

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The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street. London, Eng., Sampson Low, Marston & Co., Limited. St. Dunstan's House, Fetter Lane, E. C.

Extended piston rods appear to be regarded with increasing favor, particularly on roads with mountain grades, which necessitate a large amount of drifting with the throttle closed. In this issue Mr. J. G. Beaumont, Superintendent of Motive Power of the Southern Railway of Peru, expresses his opinion positively in their favor. In the United States many follow this practice on large cylinders, but Mr. Beaumont goes so far as to use extended rods on very small cylinders. His experience seems to justify the opinion that the practice is a good one for all locomotives.

The value and advantage of using silica in connection with graphite in making a strong and durable paint for the protection of steel and iron are outlined in a communication from the Jos. Dixon Crucible Company, printed on another page of this issue. This letter was called forth by a paragraph on page 333 of our October issue, being a brief report of opinions expressed at the recent convention of the Master Car and Loco-

motive Painters' Association, to the effect that silica was considered an adulterant of graphite paint. The manufacturers wish it to be understood that silica is used purposely and for the improvement of the paint. "It is to the graphite what alloy is to gold." It improves the wearing qualities. The letter suggests that the speakers meant silicate of alumina (clay) instead of silica. This was probably the case.

At present we are enjoying "good times." Every line of industry is fully employed and the difficulty is to secure enough skilled men to carry out the orders which are pouring in from every direction. With the flush of success there comes a danger. Good times alternate with panics and they will probably always continue to do so. A question which should have earnest attention just now is how to postpone the end of the present activity. This is admirably answered in a thoughtful, sensible editorial in "Engineering News" of September 28, which emphasizes the necessity for caution against engaging in large schemes which contribute to the further rise of prices and contribute directly toward hastening the time of trouble. We quote from the article: "It is the best possible time to pay debts and not to incur them. . . . Is it not a fact that our seasons of financial prosperity and adversity are really due to fluctuations in the tide of demand? Do we not need as much to check it in times of prosperity as to stimulate it in times of adversity? Must we not, in fact, do the one in order to do the other?" These are good suggestions to ponder over. This writer goes on to say: "It is a better time to pay debts than to buy steel rails, or bridges or rolling-stock, except in so far as these may be absolutely necessary for the profitable operation of the road. Every company which pursues this policy is not only saving money for its stockholders but is helping to prolong good times and diminish the shock of financial disaster when it comes. Its orders which would now be booked at high prices and with long delays, will be eagerly sought for at some future day, and will serve to keep some mill going that would otherwise stand idle. . . . The way to make the good times stay, then, is simply to hold in reserve a part of the forces which are now pushing the tide of prosperity on toward its flood, that they may be expended later to check the ebb, and leave at least enough water in the harbor that not so many good ships may become stranded." This is the day of large enterprises and the temptations are great, but the dangers are also great and the day of reckoning certain. Those who are wise will heed such a common sense warning so admirably expressed.

GAS ENGINES FOR SHOP DRIVING.

The rapid and substantial advancement of the gas engine as a power producer for machine and generator driving will surprise those who examine its present status with a view of using it to replace steam. By many who are not informed as to its progress it is regarded as too experimental and too uncertain for consideration as a source of power for running machines which must work every day and must not be stopped for breakdowns. The gas engine is very far from perfect, but it has now reached a stage which warrants its consideration as a reliable motor which is cheaper than the steam engine in fuel cost and attendance, and in addition to these advantages it offers a means for subdivision of power that is equal in efficiency, if not superior to that of electricity.

The reliability of the internal combustion engine is proven by those that are running all day long without stopping and many are running in buildings which are closed and locked except when the attendant comes to oil them. A 65 horse-power Westinghouse gas engine has made a wonderful record for long continuous running, which has probably not been approached in severity by any steam engine running in regular service. The one referred to is in New York City, and from Oct. 15, 1898, to Feb. 28, 1899, it averaged 22.3 hours running per day for 137 days. During this time it was idle but 230 hours and

only 49 of these were required in repairs to the engine. We are told that 26 hours were spent in replacing the igniters with new ones, and 12 hours were given to the bearings and adjustment of other parts. A continuous run of 638 hours, ending Feb. 19, is recorded. It is not necessary to say more with regard to reliability, because that engine was working under conditions more exacting than are usually confronted by steam engines.

The gas producer furnishes means for operating gas engines independently of city mains and oil or distillate may be used where it is difficult to secure appropriations for the gas plant. The attendance required for a gas producer is less than for a boiler, because the operations are almost entirely automatic. Mr. A. R. Bellamy* gives valuable records from the daily operation of a plant in England, including two 40 horse-power gas engines driven by producer gas. Two-thirds of a cent per indicated horse-power hour cover all charges for operation, where anthracite coal costs \$6.25 per ton. The producer makes 1,000 cubic feet of gas from 14 pounds of coal, including all losses, and the two engines, the producer and a steam boiler (for operating steam hammers), were attended by one laborer. The same expense for attendance would be ample for double this amount of power. The engines in this case are looked after by an uneducated man, who gives them less than two hours per day. The cost of the gas may be placed at 6½ cents per 1,000 cubic feet. The consumption of fuel is 0.939 pound per indicated horse-power per hour, including all losses, and against this may be placed the wasteful single expansion steam engine with disgracefully long steam pipes. It is well known that many such engines have been struggling for years at an expense of from five to eight pounds of coal per indicated horse-power hour. Mr. Bellamy records valuable figures for electric lighting. The power used in the case cited is 18 brake horse-power. At 83 cubic feet of fuel gas per brake horse-power hour and an average of 20 hours per week, the cost was less than 10 cents per hour for 38,000 candle power in arc lamps and 496 candle power in incandescents. The efficiency attained by the Westinghouse gas engine, as reported by Mr. Edwin Ruud†, for engines of 20 horse-power and upward with natural gas is from 10.5 to 12 cubic feet per brake horse-power hour and a special 125 horse-power engine has given the phenomenal economy of one brake horse-power for 9 cubic feet. This gas gives 1,000 British thermal units per cubic foot and the best record is an efficiency of 28.7 per cent., while 33 1/3 per cent. is promised for every day performance.

The figures for the operation of oil engines, including all charges, are not available for comparison, but we have Professor Denton's authority, based on a test of a 20 horse-power Diesel motor, expressed in his report as follows: "As the motor shows itself to be able to use oil obtainable at about two cents per gallon, the cost of a brake horse-power may be two-tenths of a cent per hour, which is slightly less than the cost of the same power from the average triple-expansion steam engine, with coal at \$3 per gross ton."

The proposition before a shop manager who is planning improvements or entirely new shops, is this: Will it be a good investment to install a gas engine equipment for the entire power plant, put in a gas producer and also provide a steam plant for heating in the winter? The man who does this may be considered bold, but he has excellent precedents and will undoubtedly save money by it. The gas producer may be run when needed, and by providing sufficient storage no gas need be made when only a part of the engine equipment is running. This simplifies night work. The subdivision of power by gas engines is easy and economical and gas fuel may be distributed much more easily than power. Quoting Mr. Bellamy again: "One horse-power at the gas plant is sufficient to force through mains one mile long, sufficient to supply 3,000 horse-power. It is probable that in certain cases it will be cheaper to run small

outlying shops of a large plant by gas engines than to drive by electric motors from a steam driven generator."

A little study of existing records reveals a most promising prospect for the internal combustion engine, whether the fuel is oil or producer gas, and the outlook for producer gas made from the cheapest forms of anthracite, down to the size known as buckwheat, is exceedingly bright. The illustrated description of the producer and gas engine plant at the Jersey City Terminal of the Erie R. R. in this issue is worthy of thoughtful attention in this connection.

LOCOMOTIVE FRONT ENDS.

The wide differences of opinion of motive power officers with regard to the arrangement of details of devices which are intended to carry out the same purpose is nowhere better illustrated than in the construction of locomotive smokeboxes. While there are several types of front end arrangements, there is practically no uniformity and no agreement as to which of a large number of designs is the best. Almost every individual road has its own design, and sometimes there are great differences in the practice of different parts of the same road in this particular.

The most satisfactory work on the front end problem was that of the committee on smokestacks and exhaust nozzles reporting to the Master Mechanics' Association in 1896, but even since that effort to improve the design of these parts we find that there are still as wide differences of opinion as before, and while the committee recommendations have often been very successful it is found that some roads have made utter failures in attempts to use them. The chaotic condition of practice in this respect is noteworthy because of the important effects of a satisfactory front end upon the economy of fuel. It does not seem sufficient to say that this variety is due to different qualities of fuel, and it is difficult to believe that each of the different designers has secured the best arrangement.

The history of this subject and its present state of development in this country are admirably presented in an exceedingly able paper by Mr. J. Snowden Bell recently read before the Western Railway Club. This paper and one presented by Mr. Willis C. Squire, before the same organization in November, 1893, contain a very satisfactory record of what has been done in this direction. Mr. Bell has made an elaborate study of the draft requirements and spark-arresting features of locomotives and sums up his opinions in the following conclusions:

1. That a smokebox of greater length than is necessary to permit the use of a sufficient area of netting to provide for free steaming, is not only useless but also positively prejudicial, as to the steaming of the engine and economy of fuel.
2. That, particularly with boilers of the present average diameter, the length from center of exhaust pot to front should not exceed, say, thirty-five inches, and that all necessary netting and draft appliances can be properly applied in a smokebox of such length.
3. That the front end should be of what is known as the "self-cleaning" type, and that the cinder pot or cinder hopper is wholly useless and a needless addition to the cost of the engine.
4. That where an open stack is employed, the taper or "choke" pattern will, if properly designed and proportioned, be more usefully and economically effective than a "straight" or cylindrical stack.
5. That the construction recommended by the American Master Mechanics' Association at its 1894 and 1896 conventions, embodying, as a whole, the most desirable and effective plan or design, under the general principles and conditions applicable to and controlling in locomotive front ends.
6. That, under certain conditions, the design of front end embodying a short smokebox, a diamond stack, low exhaust pot, and lift pipe, is as usefully and effectively applicable as that of the Master Mechanics' Association.
7. That the useful and economical effect of a locomotive front end is wholly and solely dependent upon the draft appliances and spark arresting devices employed, and that such effect will be reduced proportionately to any increase of smokebox length beyond that necessary for the application of said appliances and devices.
8. That experimental research can be advantageously made in the directions of: (a) ascertaining what reduction of smokebox length is practicable; and (b) whether or not an appliance can be produced whereby cinders may be returned to the firebox in a practically useful manner.

The ideal front end arrangement is one which will give the

* Paper read before the Manchester Association of Engineers.
† In a paper read before the Technical Society of Pittsburgh.

desired draft upon the fire and prevent sparks and fine dirt or dust from being blown out of the stack. There are differences of opinion in regard to the best disposition of the matter which is drawn through the tubes by the draft, Mr. Bell holding that the front ends should be made self-cleaning in such a way that dirt and cinders will not collect there, but that they shall be ground up and passed out of the stack in such a finely divided form as to avoid setting fires. Many agree with him in this, and a number of plans have been devised and are in successful use accomplishing this purpose. Others believe that the sparks should be retained in the front end and be removed at the end of the run in order to throw the least possible amount of dirt over the train. This opinion had able support in the discussion of Mr. Bell's paper from such men as Messrs. A. E. Manchester, J. F. Deems, F. A. Delano and G. R. Henderson.

In commenting upon some of the details of this problem in the December, 1898, issue of this paper, page 394, the following opinion was expressed.

"The front end problem is based upon the shortcomings of other parts of the locomotive, and the best way to solve it, and the only way to completely settle it, is to keep the sparks in the firebox and burn them there. In order to accomplish this, the firebox, grates and heating surface must be considered, as well as the front end. The fuel losses from sparks are not to be neglected, and it is not sufficient to merely provide for getting rid of them after they leave the firebox. Professor Goss has shown (*American Engineer*, October, 1896, page 255) that popular judgment in considering spark losses to be small is entirely wrong. Under ordinary working conditions in common practice they may amount to more than 10 per cent of the fuel value of the coal."

It is undoubtedly worth while to carefully study the causes which result in the production of sparks, the chief of which is the strong draft which is so commonly required. The most important conclusion reached in this discussion, and one which will probably become fruitful is such an increase of grate area as will enable the fuel to be kept in the firebox instead of being pulled through the tubes unconsumed by the powerful draft, which is necessitated by a small grate area. It is clear that the question is much deeper than has generally been considered, and that the fire needs as much, if not more, attention than the spark-arresting features.

Mr. William Forsyth's arguments for large grates, which appear elsewhere in this issue, are heartily commended in this connection, and it is believed that if his suggestion as to adapting the width of the firebox to the special conditions in each design of locomotive the front end difficulties will be greatly simplified.

Another phase of this question which did not receive attention in the discussion referred to is the effect of the reduction in height of the smokestacks of large locomotives. That this is an important feature of front-end design is now thoroughly appreciated by those who are increasing the size of locomotives and the influence of this fact seems likely to result in a reversion of opinion in regard to the use of draft pipes. A description of the front end arrangement of a large passenger locomotive, given in this issue, is interesting in this connection. Several well-informed men believe that this is the coming plan.

The Directors of the Wagner Palace Car Company have made an agreement with those of the Pullman Car Company, subject to ratification by the shareholders of both companies, for the sale of all the assets and property to the Pullman Company. The price per share of the Wagner stock is \$180 in cash, or it will be exchanged share for share of the Pullman stock, and the latter stock is to be increased by 200,000 shares. The action of the Wagner Directors was unanimous and they have elected to take stock in exchange for their holdings. If the action of the Directors is ratified the Wagner Company will be dissolved at the end of this year. This means the end of competition in the operation of sleeping cars on the railroads of this country, because it is not at all a promising field for a new company to attempt to enter against the strength of the two sleeping car companies combined in one concern.

CORRESPONDENCE.

SILICA IN GRAPHITE PAINT.

Editor "American Engineer and Railroad Journal":

We find the following paragraph on page 333 of the October number of the "American Engineer and Railroad Journal":

"For protective coatings for iron and steel, the Master Car and Locomotive Painters' Associations, in their recent convention, expressed preferences for oxide of iron, graphite and carbon pigment. Pure graphite was considered excellent, but this paint was liable to be adulterated with silica, which, while being a good filler, did not give good wearing qualities."

Kindly permit us to have something to say on this subject. There was, at that convention, undoubtedly considerable misunderstanding as to the nature of graphite; and in fact the nature of graphite, or rather, the varying nature of graphite, is not fully understood. The Dixon company make a silica-graphite paint, and advertise it as such; therefore the graphite cannot be said to be adulterated with silica, as the silica is put in with intent and for a purpose.

We note in the paragraph quoted, that "silica, while being a good filler, does not give good wearing qualities." We regret that no mention was made as to why the silica is not possessed of good wearing qualities. The man or men who gave voice to this statement most certainly did not understand the nature of graphite and the nature of silica. Silica is almost as refractory as graphite; it is attacked only by strong alkalis. We think, therefore, that very likely the speaker had in mind silicate of alumina or, in other and plain words, clay.

As mentioned above, the Dixon company are manufacturers of a silica-graphite paint. The graphite is the Ticonderoga graphite, chosen because of its flake formation, and because of its hardness and toughness. Ticonderoga graphite will outwear Ceylon graphite or any other form of graphite with which we are familiar, and we buy and sell all kinds.

The silica is added not only because it is a most excellent filler, but because it strengthens and hardens the coating, so that the coating of paint will better resist the wear and tear of storms of all kinds, and friction generally. It is to the graphite what the alloy is to the gold in a watch chain. Without it the wear is rapid.

A silica paint is made and sold quite extensively in England, but it is known to be a brittle paint. Graphite, especially flake graphite, forms an exceedingly elastic coating. Graphite paint with silica makes, all things considered, just as near an ideal protective coating as science and practice have been able to find.

JOS. DIXON CRUCIBLE CO.

Jersey City, October 9, 1899.

FAVORABLE OPINION OF EXTENDED PISTON RODS.

Editor The "American Engineer and Railroad Journal."

In the August number of your important paper I have read an article on extended piston rods, in which an account is given of the discussion on this topic at the Master Mechanics' convention. Having had an experience of nearly ten years in this matter, I should like to make known my views on this subject.

We have found the use of tail rods so satisfactory that we have fitted almost all our engines with them, using them with all sizes of cylinders, from 7½ inches to 20 inches.

As this is a mountain railway, our engines do almost 50 per cent of their mileage, drifting, and formerly we experienced continual trouble on account of cylinders wearing badly in the front on the lower side, which compelled us to re-bore them frequently; but since we adopted the extended piston rods, we scarcely ever have to re-bore a cylinder. I believe that anybody who gives extended piston rods a trial, will use them ever afterwards. Our practice is to pass the extended rod through the front cylinder head by a stuffing-box and gland. In this arrangement there is of course no difficulty to lubricate the rod. On the gland we generally bolt a piece of thin piping with a flange to act as a sleeve and protect the tail rod from the cold air, when it is outside of the cylinder.

I have never had any experience with the working of tail rods forming a part of the volume of the cylinder, but I believe that the resulting increased clearance will certainly cause waste of steam. An incidental advantage of the extended rods, of which we avail ourselves, is that they facilitate the lining

of the guide bars. We make the front and back glands with a nice fit, which keeps the piston rod perfectly in line with the cylinder; we key the crosshead to the piston rod, and then adjust the guides by the crosshead. If the guides are rightly set, the back gland will move easily in the stuffing-box at any point of the stroke. I believe that it will be difficult to surpass the simplicity of this method.

We have lately rebuilt in our shops at this city eight engines of the ten-wheel type which are fitted with extended piston rods. One of these was fully described and illustrated in London "Engineering," of May 26th last.

J. G. BEAUMONT,
Superintendent Motive Power and Machinery.
Southern Railway of Peru,

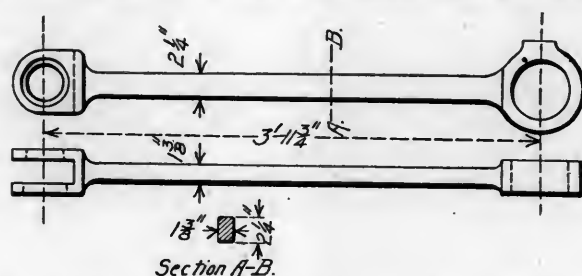
Member American Railway Master Mechanics' Association.
Arequipa, Peru,
September 1, 1899.

SECTION OF SIDE RODS.

Editor The "American Engineer and Railroad Journal."

I have read with much interest the valuable contributions on locomotive design by Mr. F. J. Cole of the Rogers Locomotive Works in several numbers of your journal, and have frequently had opportunity to compare them with our own practice, with satisfactory results. The other day, however, a broken side rod came to my notice, the proportions of which were a little different from the customary, and with your permission I would like to call Mr. Cole's attention to the same through the columns of your paper.

In 1887 we prepared designs for a lot of consolidation engines of the then prevailing size, 20x24 inch cylinders, 50-inch driving wheels and 140 lbs. boiler pressure. In calculating the dimensions for the side rods I was guided principally by the method described by Prof. Reuleaux in the third edition of "Der Konstrukteur," except that I made the parallel rods of a constant



section instead of tapering toward the ends. The dimensions thus obtained seemed sufficient to prevent excessive fibre stress due to centrifugal force, and the resistance to buckling appeared to correspond to that of the piston rod in proportion to the length.

The first set of rods made according to this design was put on a locomotive in May, 1888. When this engine, the 328, was ready to leave the shop, the general opinion among the shop people was that the rods would break before the engine got to the round house. In point of fact these rods were so strongly criticised by everybody who saw them, that I received orders the same day to change the design to dimensions corresponding to side rods of other engines of similar type in use elsewhere at that time. I attach herewith a sketch giving the principal dimensions of the back parallel rod on the first engine. The cross section measures 3 square inches. The rods were made of iron. The new cross section of the corresponding rod on the other engines of the lot was 1 1/2 x 3 1/2 inches, equal to 4 1/4 square inches of iron.

The incident passed out of my mind until a few days ago, when we received report of a broken side rod on engine 328. On investigation we found that it was the back rod, and that it had broken by accident while the engine was being put back on the track after a derailment. This was the first failure of any of the rods on this engine during a hard service of 11 1/2 years. For this reason I felt tempted to believe that the fibre stress usually permitted in locomotive side rods might be increased without risk. Still I consider Mr. Cole's figures more in accordance with modern practice, and not at all unreasonable.

EDWARD GRAFSTROM.

Office of Superintendent of Motive Power,
Pennsylvania Lines West of Pittsburgh.
October 3, 1899.

LOCOMOTIVE DESIGN.*

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Riveted Seams.

Riveted seams must necessarily be weaker than the solid plate, and due allowance should be made for the loss of strength caused by cutting away the plate for the rivet holes.

The strength of boiler seams compared to the solid plates may be taken, approximately, at 55 to 60 per cent. for single riveted lap seams, 70 to 75 per cent. for double riveted lap seams, and 82 to 87 per cent. for butt seams, with quadruple or sextuple riveted double cover strips. The rivets should be spaced as far apart as the thickness of the sheets and a tightly calked joint will permit. In single riveted seams, Fig. 1, failures may occur in three ways: (a) tearing the plate between the rivet holes, (b) shearing the rivets, (c) tearing out the plate in front of the rivet holes.

In double riveted lap seams, Fig. 2, failures may occur in three ways: (a) tearing the plate between the rivet holes, (b) shearing all the rivets, (c) tearing out the plate in front of one row of rivet holes and shearing the other row of rivets.

In butt seams with double cover strips of unequal width, Fig. 3, failures may occur in four ways: (a) tearing the plate through the outer rivet holes along the line A B, (b) tearing the plate through the rivet holes on the line C D, and shearing off the outer row of rivets on the line A B, (c) tearing out the outside cover plate in front of the rivets and shearing the rivets in the outer row A B, (d) shearing all the rivets.

The resistance of rivet iron to single shearing is usually assumed to be about 38,000 pounds per square inch of section, and from 1.7 to twice that amount in double shear. Numerous tests made at the Watertown Arsenal and by other reliable investigators, could be cited to confirm the accuracy of the generally accepted strength of rivet iron in single shear at the above mentioned figure.

In a well proportioned lap joint the net strength of the plates between the holes or the crushing strength in front of the rivets should equal the shearing strength of the rivets. As the plate is subject to greater deteriorating influences, such as pitting, grooving, and other forms of corrosion, cracking, bending, etc., the strength should be in favor of the plate, rather than of the rivets.

Let t = thickness of plate.

d = diameter of driven rivet (i. e., rivet hole).

n = number of rivets in section.

P = pitch of rivets.

S = tensile strength of plate per square inch.

R = shearing strength of iron rivets = 38,000 lbs.

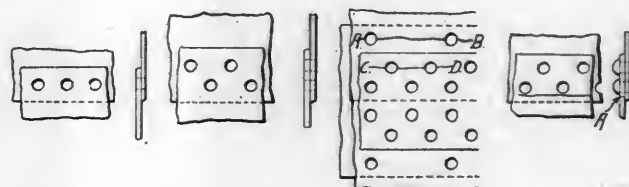


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Then:

$$\frac{P-d}{P} = \text{percentage of solid plate,}$$

$$\frac{(P-d) St}{P} = \text{strength of plate per inch of width,}$$

$$\frac{n R (d^2 .7854)}{P} = \text{strength of rivets per inch of width.}$$

The simplest way to determine the strength of butt seams with cover strips of unequal width, is to take a section equal to the pitch of the outside rivets and estimate the strength

* For previous article see page 202.

of the rivets and plate in that section. Afterwards if desired the figures may be divided by the maximum pitch for the strength per inch of width.

Example:

Steel plate $\frac{5}{8}$ inch thick, sextuple riveted butt seam, $1\frac{1}{2}$ inches diameter iron rivets, hole $1\frac{3}{16}$ inches, pitch 4 inches inner row, 8 inches outer row. Fig. 3,

Plate 55,000 lbs. ultimate strength per square inch.
 " 34,375 lbs. per square inch wide, $\frac{5}{8}$ inch thick.
 1 rivet $1\frac{1}{8}$ inches diameter line A B = 42,085 lbs.
 Plate, line A B = $(8 - 1\frac{1}{8})$ 34,375 = 234,179 lbs.
 Plate, line C D = $2 \times (4 - 1\frac{1}{8})$ 34,375 = 193,350 lbs.
 Solid plate, $8 \times 34,375 = 275,000$ lbs.
 Combined strength to shear rivet on line A B and to tear plate on line C D = 42,085 + 193,350 = 235,435 lbs.
 Percentage of solid plate, $\frac{234,179}{275,000} = 85.2$.

The friction between the plates should not be considered in calculations of riveted seams. Holes may be punched without material injury to the plates, provided they are afterwards reamed out, preferably after the plates are assembled together. The rivet holes should be slightly countersunk on the outside. This not only makes the rivet head stronger, but reduces the number which require calking, as the fillet forms a steam tight joint around the holes. The margin from the center of the rivet to the outside of the plate is usually taken at $1\frac{1}{2}$ times the diameter of the rivet, 1.5d.

A riveted joint is well proportioned when the shearing strength of the rivets is equal to the tearing or tensile strength of the plate between the rivet holes, provided the rivets are of suitable diameter and pitch to suit the thickness of the plates. If a section of the joint in question be pulled apart in a testing machine, it should fail at about the same stress by the tearing apart of one of the plates between the holes or by the shearing of the rivets. Butt joints with inside cover strips wider than the outside may, however, fail by a combination of tearing and shearing.

It is evident that to obtain the highest percentage of strength in a riveted joint, the least amount of metal should be cut away for the rivet holes on any given line. It therefore follows that as the area of a solid circular body, such as a rivet, increases according to the square of its diameter, while the holes in the plate weaken it only in proportion to their diameter, or that the strength of the plate depends entirely upon the amount that is cut away by the holes in any given direction, the best results are obtained when the pitch of the rivets is limited only by the stiffness of the plate to withstand the tendency to force them apart in calking. The tightness and stanchness of the joint is therefore the limiting factor, in the pitch and diameter of the rivets used for joining together plates of moderate thickness, with the ordinary forms of single and double lap joints.

The sizes of rivets used in locomotive boilers range from $\frac{3}{8}$ inch to $1\frac{1}{4}$ inches in diameter, and the holes or the size of the rivet after it is driven from $11/16$ inch to $1\frac{5}{16}$ inches. The diameters before driving vary by eighths of an inch, as follows: $\frac{3}{8}$, $\frac{7}{16}$, $\frac{1}{2}$, $1\frac{1}{8}$ and $1\frac{1}{4}$ —the intermediate sizes in sixteenths being seldom used. Although much greater theoretical uniformity in joints may be made when the shearing of the rivets and the tearing of the plates nearly equal each other, yet in practice it is more convenient not to use the intermediate diameters, but allow a greater variation of strength between the plate and the rivets. It is rarely that the $1\frac{1}{4}$ inch diameter rivet is exceeded. The great pressures required to make the metal flow properly and fill the holes, render it better practice with ordinary facilities to use triple riveted lap joints for the circumferential seams and sextuple butt joints for the longitudinal seams of unusually large boilers. In view of these limitations the proportions of riveted joints are usually modified to suit the actual rather than the theoretical conditions, the diameters of rivets used being determined largely by the practical considerations involved in their driving.

The proportions of riveted joints are usually taken from tables which have been worked out and carefully prepared to suit the facilities and requirements of different establishments or railroads. A much greater uniformity may thus be obtained than by calculating the joints as required. The pitch, number and diameter of the rivets are thus determined once for all to suit the various thicknesses of plates and style of joints to give uniformity between the strength of the rivets, and to obtain the highest percentage compared to the solid or unperforated plate.

Lap joints should never be used for the longitudinal seams of the cylindrical portion of the boilers, especially where the plates exceed $\frac{3}{8}$ inch in thickness. Any style of lap joint, whether reinforced with welts, strips, or other forms of strengthening plates, necessarily pulls obliquely and requires a departure from a circular shape, giving rise to unequal strains. Any movement, vibration, or bending caused by the pressure not being equal at all parts of the circumference is liable to be concentrated at a lap joint, and owing to the pull not being in line with the sheets may in time cause a crack to start. Several explosions due to this cause came under the writer's personal observation. The cracks, A, Fig. 4, always started from the inside, extending in one case 30 inches long, and at the time of failure $\frac{1}{4}$ inch only was left of the solid metal. Butt joints do not require the sheets to be distorted, but enable the plates to be joined together without altering the circular form at any point, or having any tendency to pull obliquely at the joint.

No precise rule can be laid down for the diameter of the rivets to suit the different forms of joints. In a general way, for punched holes, the diameter of rivets should not be much less than $1\frac{1}{2}$ times the thickness of the plates. Unwin gives the rule:

$$d = 1.2 \sqrt{t}$$

where d = diameter of rivet before driving.

t = thickness of plate.

The following table is taken from the same source, based upon the above formula:

DIAMETERS OF RIVETS FOR DIFFERENT THICKNESSES OF PLATES.

Thickness of plate, t.	Diameter of rivets, d.	Diameter of rivets after riveting, 1.04 d.
$\frac{1}{4}$	0.60	$\frac{5}{8}$ 0.59
$\frac{5}{16}$	0.67	$\frac{11}{16}$ 0.72
$\frac{3}{8}$	0.73	$\frac{3}{4}$ 0.78
$\frac{7}{16}$	0.79	$\frac{11}{16}$ 0.85
$\frac{1}{2}$	0.85	$\frac{3}{4}$ 0.91
$\frac{5}{8}$	0.90	$\frac{3}{4}$ 0.91
$\frac{3}{4}$	0.95	$\frac{11}{16}$ 0.97
$\frac{7}{8}$	1.04	$1\frac{1}{8}$ 1.10
$\frac{1}{2}$	1.12	$1\frac{1}{8}$ 1.17
1	1.20	$1\frac{1}{8}$ 1.24

SHEARING STRENGTH OF RIVET IRON ASSUMED TO BE 38,000 POUNDS PER SQUARE INCH.

Driven Size, Inch.	Area.	1 Rivet.	2 Rivets.	3 Rivets.	4 Rivets.	5 Rivets.
$\frac{3}{8}$	.2185	9.443	18,886	28,329	37,772	47,215
$\frac{7}{16}$	.3063	11,658	23,316	34,974	46,532	58,290
$\frac{1}{2}$	.3712	14,106	28,212	42,318	56,424	70,530
$\frac{5}{8}$	.4418	16,788	33,576	50,364	67,152	83,940
$\frac{3}{4}$	.5185	19,703	39,406	59,109	78,812	98,515
$\frac{7}{8}$	.613	22,849	45,698	68,547	91,395	114,245
$1\frac{1}{8}$	.6903	26,231	52,462	78,693	104,924	131,155
1	.7854	29,845	59,690	89,535	119,380	149,225
$1\frac{1}{8}$	.8865	33,691	67,382	101,073	134,764	168,455
$1\frac{1}{4}$	.9940	37,772	75,544	113,316	151,088	188,860
$1\frac{3}{8}$	1.1075	42,085	84,170	126,255	168,340	210,425
$1\frac{1}{2}$	1.2272	46,634	93,268	139,902	186,536	233,170
$1\frac{3}{4}$	1.3530	51,414	102,828	154,242	205,656	257,070
$1\frac{7}{8}$	1.4849	56,426	112,852	169,278	225,704	282,130
$1\frac{5}{8}$	1.6230	61,674	123,348	185,022	246,996	308,370
$1\frac{1}{2}$	1.7671	67,156	134,300	201,450	268,600	335,750

This table is taken in part from the Report of the Committee on Riveted Joints, American Railway Master Mechanics' Association, Proceedings of 1895, page 217.

FIG. 5.—SINGLE RIVETED LAP SEAM.

Thickness of sheet.	Diameter of rivets.	Diameter of rivet hole.	A	B	C	Per cent. of solid plate.
$\frac{1}{4}$	$\frac{5}{8}$	$\frac{11}{8}$	$1\frac{1}{8}$	1	2	63
$\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{8}$	2	$1\frac{1}{8}$	$2\frac{3}{4}$	59
$\frac{3}{8}$	$\frac{3}{4}$	$\frac{11}{8}$	2	$1\frac{1}{8}$	$2\frac{3}{4}$	59
$\frac{1}{2}$	$\frac{3}{8}$	$\frac{11}{8}$	$2\frac{1}{8}$	$1\frac{1}{8}$	$2\frac{3}{4}$	56
$\frac{1}{2}$	1	$1\frac{1}{8}$	$2\frac{3}{8}$	$1\frac{1}{8}$	$3\frac{1}{4}$	55
$\frac{1}{2}$	1	$1\frac{1}{8}$	$2\frac{3}{8}$	$1\frac{1}{8}$	$3\frac{1}{4}$	55
$\frac{5}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$2\frac{1}{2}$	$1\frac{3}{4}$	$3\frac{1}{2}$	52
$\frac{11}{8}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$2\frac{1}{2}$	$1\frac{3}{4}$	$3\frac{1}{2}$	52
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$2\frac{3}{8}$	$1\frac{3}{8}$	$3\frac{1}{4}$	50

FIG. 6.—DOUBLE RIVETED LAP SEAM.

Thickness of sheet.	Diameter of rivets.	Diameter of rivet hole.	D	E	F	G	Per cent. of solid plate.
$\frac{1}{4}$	$\frac{5}{8}$	$\frac{11}{8}$	3	$1\frac{1}{8}$	$3\frac{3}{8}$	1	76
$\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{8}$	$3\frac{1}{4}$	$1\frac{1}{8}$	4	$1\frac{1}{8}$	74
$\frac{3}{8}$	$\frac{3}{4}$	$\frac{11}{8}$	$3\frac{1}{4}$	$1\frac{1}{8}$	$4\frac{1}{4}$	$1\frac{1}{8}$	71
$\frac{1}{2}$	$\frac{3}{8}$	$\frac{11}{8}$	$3\frac{1}{4}$	$1\frac{1}{8}$	$4\frac{1}{4}$	$1\frac{1}{8}$	71
$\frac{1}{2}$	1	$1\frac{1}{8}$	$3\frac{1}{4}$	$1\frac{1}{8}$	5	$1\frac{1}{8}$	70
$\frac{1}{2}$	1	$1\frac{1}{8}$	$3\frac{1}{4}$	$1\frac{1}{8}$	5	$1\frac{1}{8}$	69
$\frac{5}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{3}{4}$	2	$5\frac{1}{2}$	$1\frac{3}{4}$	68
$\frac{11}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$3\frac{3}{4}$	2	$5\frac{1}{2}$	$1\frac{3}{4}$	67
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$3\frac{3}{4}$	2	$5\frac{3}{4}$	$1\frac{3}{8}$	65
$\frac{11}{8}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$3\frac{3}{4}$	2	$5\frac{3}{4}$	$1\frac{3}{8}$	65
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$3\frac{3}{4}$	2	$5\frac{3}{4}$	$1\frac{3}{8}$	65
$\frac{11}{8}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$3\frac{3}{4}$	2	$6\frac{1}{4}$	$2\frac{1}{8}$	62
1	$1\frac{1}{2}$	$1\frac{1}{8}$	$3\frac{3}{4}$	2	$6\frac{1}{4}$	$2\frac{1}{8}$	61

Double riveted lap seams are not suitable for plates exceeding $\frac{7}{8}$ inch in thickness, when rivets driven in $1\frac{1}{8}$ holes are used. In order to preserve the uniformity existing between the tearing or strength of the plate between the rivet holes and the shearing of the rivets, the diameter of the rivets must be in-

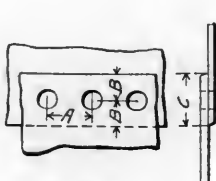


Fig. 5.

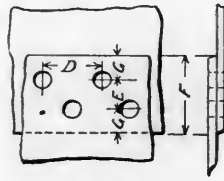


Fig. 6.

creased after the thickness exceeds $\frac{7}{8}$ inch. Triple riveted seams are more suitable for the circumferential seams of plates over $\frac{7}{8}$ inch thick.

FIG. 7.—QUADRUPLE RIVETED BUTT SEAMS.

Thickness of sheet.	Diameter of rivets.	Diameter of rivet hole.	H	I	J	K	L	M	N	Per cent of solid.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
$\frac{1}{4}$	$\frac{5}{8}$	$\frac{11}{8}$	$1\frac{1}{8}$	$2\frac{1}{4}$	1	$4\frac{1}{4}$	$8\frac{1}{4}$	$\frac{7}{8}$	$\frac{1}{4}$	81
$\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{8}$	2	$2\frac{3}{8}$	1	$4\frac{3}{8}$	$8\frac{3}{8}$	$\frac{7}{8}$	$\frac{1}{4}$	83
$\frac{3}{8}$	$\frac{3}{4}$	$\frac{11}{8}$	$2\frac{1}{8}$	$2\frac{1}{4}$	$1\frac{1}{8}$	$4\frac{3}{4}$	$9\frac{1}{4}$	$\frac{7}{8}$	$\frac{1}{4}$	81
$\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{8}$	$2\frac{1}{4}$	$2\frac{3}{8}$	$1\frac{1}{8}$	$4\frac{3}{4}$	$9\frac{3}{8}$	$\frac{7}{8}$	$\frac{1}{4}$	82
$\frac{3}{8}$	$\frac{3}{4}$	$\frac{11}{8}$	$2\frac{3}{8}$	$2\frac{1}{4}$	$1\frac{1}{8}$	5	$9\frac{1}{4}$	$\frac{7}{8}$	$\frac{1}{4}$	81
$\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{8}$	$2\frac{1}{2}$	$2\frac{3}{8}$	$1\frac{1}{8}$	$5\frac{1}{2}$	$10\frac{1}{4}$	$\frac{7}{8}$	$\frac{1}{4}$	77
$\frac{5}{8}$	1	$1\frac{1}{8}$	$2\frac{3}{8}$	3	$1\frac{1}{8}$	6	12	$\frac{7}{8}$	$\frac{1}{4}$	78

FIG. 8.—SEXTUPLE RIVETED BUTT SEAMS.

Thickness of sheet.	Diameter of rivets.	Diameter of rivet hole.	P	Q	R	S	T	U	Per cent. of solid plate.
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
$\frac{3}{8}$	$\frac{3}{4}$	$\frac{11}{8}$	$3\frac{1}{4}$	$1\frac{1}{8}$	$7\frac{3}{4}$	$12\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{8}$	89
$\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{8}$	$3\frac{3}{8}$	$1\frac{1}{8}$	$7\frac{3}{8}$	$12\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	88
$\frac{3}{8}$	$\frac{3}{8}$	$\frac{11}{8}$	$3\frac{1}{8}$	$1\frac{1}{8}$	$8\frac{3}{4}$	14	$\frac{3}{8}$	$\frac{1}{8}$	87
$\frac{1}{2}$	1	$1\frac{1}{8}$	$3\frac{3}{4}$	$1\frac{1}{8}$	$9\frac{3}{4}$	$15\frac{3}{4}$	$\frac{3}{8}$	$\frac{1}{4}$	86
$\frac{5}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	4	$1\frac{1}{8}$	$10\frac{3}{4}$	$17\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	85
$\frac{11}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$4\frac{1}{4}$	$1\frac{1}{8}$	11	$17\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	85
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{1}{8}$	12	$19\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	84
$\frac{11}{8}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{1}{8}$	12	$19\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	83
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{1}{8}$	12	$19\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	83
$\frac{11}{8}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{1}{8}$	$12\frac{1}{4}$	21	$\frac{5}{8}$	$\frac{1}{4}$	81
1	$1\frac{1}{2}$	$1\frac{1}{8}$	$4\frac{1}{2}$	$2\frac{1}{8}$	$12\frac{1}{4}$	21	$\frac{5}{8}$	$\frac{1}{4}$	80

Firebox Seams.

For firebox seams the margin is made less than usual, the strength being a secondary matter to the tightness of the seam. A long lap is liable to burn, besides being more difficult to keep calked when exposed to the heat and flames of the fire. Fig. 10 shows the usual proportions for firebox seams.

FIG. 9.—BOILER RIVETS.

Diameter of rivet. inches.	Button Wide. A.	Heads Thick. B.	Cone Wide. C.	Heads Thick. E.	Countersunk Wide. H.	Heads Thick. U.
$\frac{1}{2}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{11}{8}$	$\frac{3}{4}$	$\frac{1}{4}$
$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{11}{8}$	$\frac{1}{2}$	$\frac{1}{8}$
$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{11}{8}$	$1\frac{1}{8}$	$\frac{3}{8}$
$\frac{3}{4}$	$1\frac{1}{4}$	$\frac{3}{4}$	$1\frac{1}{4}$	$\frac{11}{8}$	$1\frac{1}{4}$	$\frac{1}{2}$
$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{1}{2}$
1	$1\frac{3}{4}$	$\frac{3}{4}$	$1\frac{3}{4}$	$\frac{11}{8}$	$1\frac{3}{4}$	$\frac{3}{4}$
$1\frac{1}{4}$	2	1	$2\frac{1}{8}$	$1\frac{1}{2}$	$2\frac{1}{8}$	$\frac{3}{4}$

The sizes of rivets are taken from Messrs. Hoopes & Townsend's catalogue, and represent the usual commercial dimensions of heads. The angle of the sides of heads for countersunk rivets is approximately 60 degrees, although the figures given range slightly from this angle in some of the sizes.

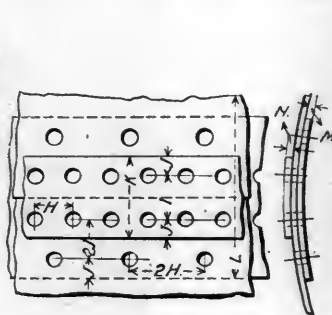


Fig. 7.

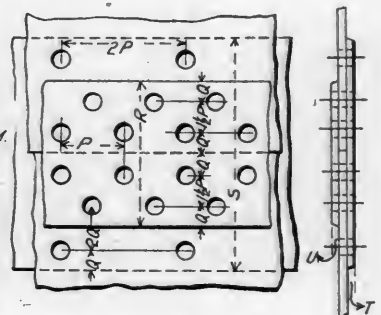


Fig. 8.

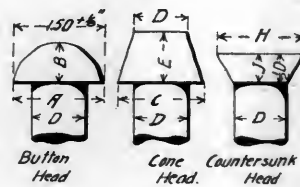


Fig. 9.

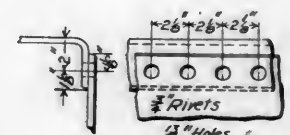


Fig. 10.

PROPORTIONS OF RIVET HEADS.

Button Heads.

Diameter head = $1\frac{1}{2}$ diameter shank + $\frac{1}{8}$ inch.
Depth of head = $\frac{1}{16}$ diameter of head.

Countersunk Heads.

Depth of head = $\frac{1}{2}$ diameter of shank.
Bevel of head = 60 degrees (exactly).

Diameter of rivet.	Button heads. A.	Button heads. B.	Countersunk heads. H.	Countersunk heads. J.
$\frac{3}{8}$	$\frac{11}{8}$	$\frac{1}{2}$	$\frac{11}{8}$	$\frac{1}{2}$
$\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{8}$	$\frac{11}{8}$	$\frac{1}{2}$
$\frac{3}{8}$	$1\frac{1}{8}$	$\frac{11}{8}$	1	$\frac{1}{2}$
$\frac{1}{2}$	$1\frac{1}{4}$	$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{3}{8}$
$\frac{3}{8}$	$1\frac{1}{8}$	$\frac{11}{8}$	$1\frac{1}{8}$	$\frac{1}{2}$
1	$1\frac{3}{4}$	$\frac{3}{4}$	$1\frac{3}{4}$	$\frac{1}{2}$
$1\frac{1}{4}$	2	$\frac{11}{8}$	$1\frac{3}{4}$	$\frac{1}{2}$
$1\frac{3}{8}$	$2\frac{1}{8}$	1	$2\frac{1}{8}$	$\frac{1}{2}$

The above table is adapted from the rivet proportions recommended by the Pencoyd Iron Works. The sizes represent heads of symmetrical proportions.

The proportions given for the various styles of seams represent what is known to be good practice. With good workmanship no trouble should be experienced in making perfectly tight work even with the wide pitches used for the thinner sheets.



Twelve-Wheel Freight Locomotive with Wide Firebox—D. L. & W. Ry.

J. W. FITZGIBBON, *Superintendent of Motive Power.*BROOKS LOCOMOTIVE WORKS, *Builders.*

TWELVE-WHEEL FREIGHT LOCOMOTIVES.

Delaware, Lackawanna & Western Railroad.

Built by the Brooks Locomotive Works.

Drawings and a photograph of the new 12-wheel freight locomotives recently built by the Brooks Locomotive Works for the Delaware, Lackawanna & Western, have been received from the builders and we show an engraving of the photograph and cross sections of the engine because of the use of the wide firebox. Fifteen of these engines have been built and we believe that with the exception of the very heavy Baldwin mountain pushing locomotives on the Lehigh Valley (*American Engineer*, December, 1898, page 395) these are the largest to be fitted with wide fireboxes. They are believed to be the largest wide firebox road engines in use. This fact, however, is interesting chiefly because of the example showing the tendency toward the more general use of fireboxes of this type. These engines also have 12-inch piston valves, which we understand are of the form illustrated on page 366 in this issue, with the new arrangement of packing rings, which are so made as to prevent the steam pressure from setting out the rings.

The total weight is 205,000 pounds, the weight on the drivers is 166,000 pounds, the cylinders are 21 by 32 inches and the driving wheels are 54 inches in diameter. With 200 pounds boiler pressure the tractive power will be about 47,000 pounds. Many of the details are similar to those of the heavy engines by the same builders for the Illinois Central, illustrated last month, and for this reason we show only the photograph and sections of the firebox. It is interesting to note that the main crank pins are enlarged in the wheel fits to $7\frac{1}{4}$ inches, while the side rod fits are $7\frac{1}{2}$ inches. We hope to see this practice become general, and for all crank pins, the enlargement is also applied to the third pair of drivers in this case but not to the forward and rear wheels. The main driving journals are 9 by 11 inches. The piston rods are extended. The frames have a single bar at the front ends and these and the equalization are like those of the Illinois Central engines referred to. The Bell patent front end is used with an extension $67\frac{1}{2}$ inches long from the tube sheet and 81 inches outside diameter. The air brake cylinders are placed with the rods vertical, under the boiler and immediately back of the first pair of drivers; the brake shoes are back of the driving wheels, giving an upward thrust to the frames. This is a rather important detail to which considerable attention is now given in very heavy locomotives. The bracing of the guide yoke is worthy of notice. It is supported from the rear by brackets formed by turning up the ends of the top bars of the main frames at the splice, from

the boiler by a $\frac{3}{8}$ -inch plate brace and from the smokebox by $2\frac{1}{2}$ -inch rod braces.

The boiler is large, with 3,168 square feet of heating surface and 82.4 square feet of grate area. The grates are of the water-tube type and the firebox is 123 by 97 inches in size. The heating surface of the firebox is very large, even larger than that of the Lehigh Valley pushing engines. The latter engines have 215 square feet of heating surface in the firebox and the D. L. & W. engines have 218 feet. The firebox heating surface of the Brooks engines for the Great Northern (*American Engineer*, January, 1898, page 1) is the largest of which we have record, being 235 square feet. The shape of the firebox is a noteworthy example of the present tendency to maintain a uniform curve in the side sheets and to avoid the flat portions of these sheets that were formerly the rule in fireboxes of this type. The accompanying small engraving illustrates two examples from former practice in this respect on another road and the improvement will be seen at a glance. This change in the form of the firebox is believed to be a very important way to reduce the breakage of stay bolts, and this may become a strong argument in favor of this type of firebox even if the dimensions are not carried as far as in this case, where fine anthracite is used.

The height of the boiler above the rails is 9 feet $2\frac{1}{2}$ inches, which is rather unusual, although it is not as great as that of the Illinois Central engines, in which this dimension is 9 feet 8 inches. The height of the center of the boiler of the large locomotive on the Union Railway above the rails is 9 feet $3\frac{3}{4}$ inches.

The following table gives a summary of the chief dimensions of the D. L. & W. locomotives:

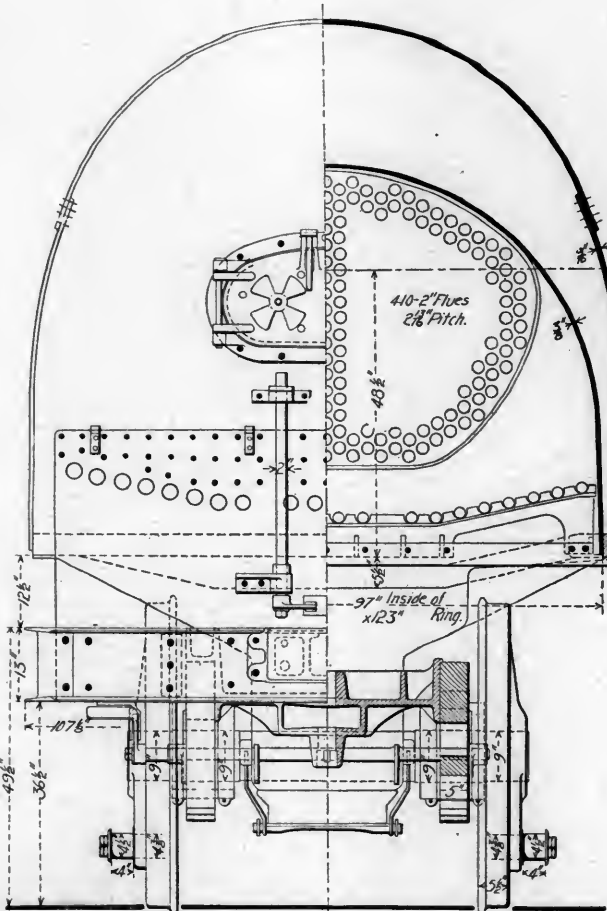
Type	12-wheel freight
Gauge	4 ft. $8\frac{1}{2}$ in.
Kind of fuel to be used	Fine anthracite coal
Weight on drivers	166,000 lbs.
Weight on trucks	39,000 lbs.
Weight, total	205,000 lbs.
Weight, tender, loaded	106,000 lbs.

General Dimensions.

Wheel base, total, of engine	25 ft. 9 in.
Wheel base, driving	15 ft. 0 in.
Wheel base, total, engine and tender	50 ft. 4 in.
Length over all, engine	37 ft. 4 in.
Length over all, total, engine and tender	60 ft. 2 in.
Height, center of boiler above rails	9 ft. $2\frac{1}{2}$ in.
Height of stack above rails	15 ft. 1 in.
Heating surface, firebox	218 sq. ft.
Heating surface, tubes	2,950 sq. ft.
Heating surface, total	3,168 sq. ft.
Grate area	82.4 sq. ft.

Wheels and Journals.

Drivers, number	Eight
Drivers, diameter	54 in.
Drivers, material of centers	Cast steel
Truck wheels, diameter	30 in.
Journals, driving axle	9 in. by 11 in.
Journals, truck	5 in. by 12 in.
Main crank pin, size	6 in. by 6 in.
Main coupling pin, size	7 in. by 5 in.
Main pin, diameter wheel fit	7 in.

[illegible]

Firebox.

Firebox, type.....	Wide, over wheels
Firebox, length.....	123 in.
Firebox, width.....	97 in.
Firebox, depth, front.....	74 in.
Firebox, depth, back.....	64½ in.
Firebox, material.....	Steel
Firebox, thickness of sheets, crown ¾ in.; tube ¾ in.; side and back ¾ in.	
Firebox, mud ring, width.....	back and sides ¾ in.; front 4 in.
Firebox, water space at top.....	back 4½ in.; front 4 in.
Grates, kind of.....	Water tube
Tubes, number of.....	410
Tubes, material.....	Charcoal iron
Tubes, outside diameter.....	2 in.
Tubes, length over tube sheets.....	13 ft. 10½ in.

Smokebox

Valves, kind of.....	Improved Piston
Valves, greatest travel.....	6 1/4 in.
Valves, steam lap (inside).....	1 in.
Valves, exhaust lap or clearance (outside).....	Line and Line
Lead in full gear.....	1/16 in. negative

Other Parts.

Boiler.

Type	8-Wheeled
Tank, type.....	B. L. W. sloping top
Tank, capacity for water.....	5,000 gal.
Tank, capacity for coal.....	10 tons
Tank, material.....	Steel
Tank, thickness of sheets.....	¼ in.
Type of under frame.....	Steel channel
Type of springs.....	Double Elliptic
Diameter of wheels.....	33 in.
Diameter and length of journals.....	5 in. x 9 in.
Distance between centers of journals.....	5 ft. 5 in.
Diameter of wheel fit on axle.....	6 in.
Diameter of center of axle.....	5½ in.
Length of tender over bumper beams.....	21 ft. 8½ in.
Length of tank.....	19 ft. 6 in.
Width of tank.....	10 ft. 0 in.
Height of tank not including collar.....	60 in.
Type of draw gear.....	M. C. B. Gould

Type	8-Wheeled
Tank, type.....	B. L. W. sloping top
Tank, capacity for water.....	5,000 gal.
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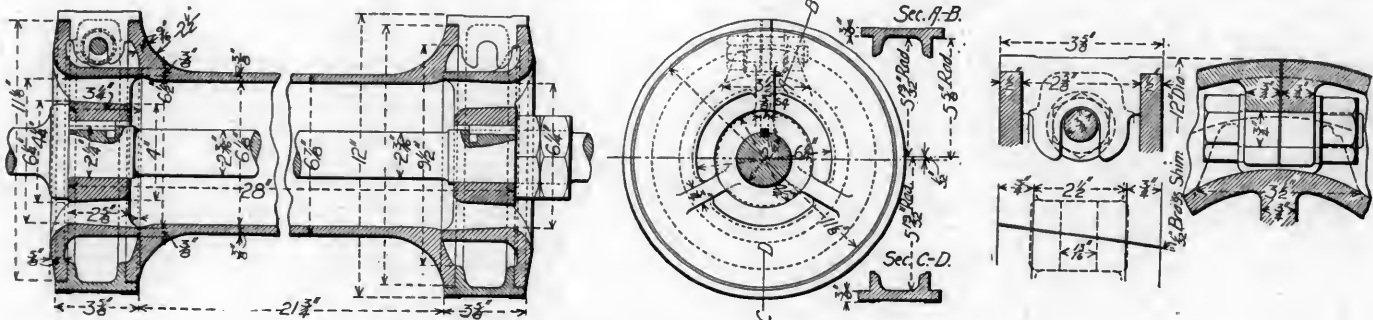
A NEW PACKING RING FOR PISTON VALVES.

The Brooks Locomotive Works.

The development of piston valves for locomotives has been interesting, and by courtesy of the Brooks Locomotive Works a newly perfected improvement is shown in the accompanying engraving, which illustrates the design used in the very large 12-wheel freight locomotive for the Illinois Central, which we illustrated last month.

In our issue of June of the current volume Mr. F. M. Whyte, now Mechanical Engineer of the New York Central, directed attention to the fact that in endeavoring to secure the proper bearing area of packing rings for piston valves the tendency toward increased friction, on account of the action of the stem in setting out the packing against the bushing was not always considered. He also showed the importance of keeping the edge of the packing rings which control the admission of steam at or very near the extreme ends of the valve, in order to avoid wire-drawing of the steam in passing through the tortuous passages caused by the projecting ends of the valves past the edge of the packing. Both of these matters have received attention in the design now illustrated. The steam pressure can have no effect in changing the diameter of the packing ring and the edge of the packing is at the extreme end of the valve.

This packing is entirely different in principle from that illustrated on page 303 of our October issue. It does not depend upon close fitting to keep the steam from getting under the ring, but the ring is solid and arranged so that it does not matter whether the steam gets under it or not. The packing is made in one solid piece in the form of a bull ring, provided with lugs on the inside to permit of adjusting its size by the introduction of a shim of the proper thickness into a saw cut,



An Improved Form of Piston Valve Packing.

through the ring, the lugs serving to provide means for bolting the joint so as to make the ring continuous as far as the steam is concerned. This packing ring is first turned up of larger diameter than the bore of the bushing. The required amount is then cut out on a bevel across the ring and a shim of the required thickness is inserted in the slot. The ring is then clamped together by a bolt, with the shim, and accurately turned up to the proper size so that the outside is a true circle. The use of the shim permits of adjustment to the proper fit in the bushing and also makes it possible to provide for wear by putting in a thicker shim.

This construction requires careful fitting of the bushing and it may be necessary to ream the bushing to accurately fit the valve after the bushing is in place. Once accurately fitted the packing ought to remain tight for a long time. This design seems to have the advantages of a plain plug valve and an additional one in that the valve may at any time be made tight after wearing, and with comparatively little expense.

The engraving shows the construction of the valve itself, the form of the follower and the method of holding the packing from turning by means of lugs cast on the follower, which embrace the joint in the packing ring. The valves of this form for the large Illinois Central engine are 12 inches in diameter. We are informed that the rings are to have several parallel grooves similar to those in the pistons of gas engines, which will probably prolong the period of tightness.

STORED ENERGY REQUIRED IN TRAINS AT DIFFERENT VELOCITIES.

By P. H. Dudley.

With the present heavy and long high-speed trains the stored energy required to overcome the inertia often is the limiting factor of the speed which can be attained.

The locomotive must develop this amount as well as that required to overcome all other resistances, as the wind, gradients, curves, journal and rolling friction on rails.

No. 11, one of the through trains leaving Grand Central Station with ten cars, is 809 feet long from tip of pilot to rear of buffer, the average weight being 650 tons. With eleven cars the length is 880 feet, one-sixth of a mile, quite as long and much heavier than the slow freight trains twenty years ago.

The stored energy in foot-pounds required for a 650-ton passenger train at various speeds, including 10 per cent. of rotation of wheels, is as follows:

Speed in Miles per Hour.	Foot-pounds Stored Energy Required.	Difference.
10	4,776,200	4,776,200
20	19,162,000	13,385,800
30	43,043,000	23,881,000
40	76,505,000	33,462,000
45	96,811,000	20,306,000
50	119,548,000	22,737,000
55	144,573,000	25,025,000
60	172,172,000	27,599,000

The locomotives, so far as ordinary train resistance is concerned, would have no difficulty in maintaining the speed when once attained at 50, 55 or 60 miles per hour. To raise the train

from a speed of 50 to 55 miles per hour requires over 25,000,000 foot-pounds of energy stored in the train for the higher speed. With an increase of 500 pounds additional draw-bar tension, this would require a run of ten miles to store the needed energy. A signal or slow-down may reduce the speed, and all the energy from the higher to the lower speed destroyed by the brakes. The energy must be restored to the train before it can regain its running speed, but whether the lost time can be made depends upon the distance to be run and the ability of the locomotive to store up energy in the train much above the average running speed. The stored energy is also large in slower and heavier freight trains.

The recent 80-car freight trains' gross load, about 3,500 tons, at 20 miles per hour, requires over 100,000,000 foot-pounds of energy; and when the speed is increased to 30 miles per hour on a descending gradient, 277,556,000 foot-pounds. This stored energy is practically equal to that which is computed for the projectile of the new 16-inch gun when fired. The projectile will weigh 2,370 pounds, and at 2,000 feet velocity per second the stored energy will be 234,400,000 foot-pounds. A 12-inch projectile of 1,038 pounds, at 2,000 feet velocity has 52,000,000 pounds of stored energy. Our present fast passenger trains and the heavy freight trains daily develop and harmlessly destroy greater quantities of energy than the heaviest ordnance. —"New York Railroad Men."

THE SAND BLAST IN RAILROAD WORK.

The sand blast has been in use for many years and its development has been steady, but it will be more rapid now that compressed air power is so generally available. When the rotary blower was used for the air supply, the work was very satisfactory, but with higher pressures from compressors it is much more rapid and effective and the number of uses for the sand blast has vastly increased. The possibilities need only to be appreciated to compel much greater extension.

The remarkably satisfactory results with the sand blast in cleaning the old paint from the 155th St. Viaduct, New York, preparatory to painting the girders for the tests described in our August, 1898, issue, page 259, have done a great deal to show its value. The surfaces were required to be perfectly clean, which could not be accomplished by wire brushes or scrapers. At that time the engineer in charge, Mr. E. P. North, consulted 20 prominent engineers as to the advisability of using the sand blast for this purpose and the replies all stated that no better method of removing scale, rust and old paint from all parts of an iron or steel structure was known. This correspondence clearly brought out the importance of absolutely clean metallic surfaces for the reception of paint. The sand blast will reach all parts of a structure which are inaccessible to a brush and scraper, and it will do the work cheaper than any other method. This was proven some time ago by Mr. L.



Fig. 1.—King Sand Blast Machine.

F. Smith, assistant engineer in charge of bridges of the City of Baltimore, in the case of the bridge over the Pennsylvania Railroad at Argyle Ave. The bridge had not been painted for 20 years, and the rust and scale were over $\frac{1}{4}$ inch thick, the pitting was $\frac{1}{16}$ inch deep. Hand cleaning, which was not effective or satisfactory, cost 5 cents per square foot, and on trying the sand blast the work was done both better and cheaper.

Bridge work is a large field for this process, and in fact any work requiring the removal of paint or scale from metallic surfaces, for subsequent painting, plating or enameling. It is specially successful in cleaning castings as they come from the molds. It will remove sand that is burned in, and at one operation it will prepare a rough sandy casting for nickel plating. Locomotive tenders are cleaned from old paint, car wheels are cleaned at the foundry, old files smoothed off for recutting; painted woodwork may be sanded and many other fields of usefulness have been found, such as the cleaning of the bottoms of ships.

The sand blast for the removal of paint from tenders is gaining in favor among railroads. At the Dennison shops of the P., C., C. & St. L. Ry., it has been used for this purpose for over three years, and the average cost of cleaning a tender ready for painting has been \$2.50, this method being preferred to all others. This cost has probably been greatly reduced since our information was received, about 18 months ago. On

the Erie quartz sand or quartz and deposit sand mixed in equal proportions are used with an air pressure of about 100 lbs. On the Atchison, Topeka & Santa Fe hand scrapers and gas burners were formerly used on tenders, chemical softening of the paint had also been tried, but these have now given place to the sand blast. A 4,000-gallon tank is completely cleaned in 4 hours and everything is cleaned off right down to the metal. If there is any pitting and progressive rusting the sand reaches it and cuts it out. On this road about 10 cubic feet of sand will clean a 4,000-gallon tank at a labor cost of 50 cents, while the entire cost does not exceed 85 cents per tender. These are figures which we have from officers of the road. Car journal brasses which have been used were formerly cleaned in a bath of lye, the sand blast is now used, and it is more rapid and also leaves the surfaces looking like new. It is used to clean driving wheels, dome casings, remove the scale from dry pipes and for many other purposes.

Mr. B. Haskell, Superintendent of Motive Power of the Chicago & West Michigan Ry., described his experience with the sand blast in a paper before the Western Railway Club (American Engineer, April, 1899, page 129), in which he said: "In



Fig. 2.—Sand Blast Machine at Work.

the preparation of a new locomotive for a priming coat of paint the surface is brought to condition by the air and sand blast, instead of by hand abrading, the latter process requiring about 35 man-hours at a cost of \$3.50, while the sand blast requires two man-hours at 14 cents per hour, and two man-hours at 10 cents per hour, or 48 cents, a saving of \$3.02 by the sand blast. The sand blast is also used in frosting deck glass for passenger cars, the cost for labor and material being 12 cents, a saving of 60 cents.

A very simple and satisfactory sand blast machine manufactured by the King Improved Sand Blast Co., is illustrated in the accompanying engraving. Fig. 1 shows the second of three sizes. This machine is hung from a convenient crane, and is easy to handle. A smaller one, No. 1, using air from a rotary blower at eight ounces pressure, is used for cleaning the light castings used in stoves. In this work one man with a sand blast apparatus does the work of five men with brushes. The No. 2 machine, which is shown here, is used with compressed air, and is much more powerful. It is adapted to nearly all the heavier work that may be done by the sand blast.

Three hundred car wheels can be thoroughly cleaned per day with a machine of this size.

It is desirable to have a room about 10x10x10 feet set apart for the cleaning. A small exhaust fan may be arranged to keep the air free from dust. A sharp or quartz sand is required; it should be perfectly dry and free from all foreign substances which would tend to clog the sand valve or hose. The sand may be used over and over until too fine to cut effectually. The bucket may be hung by a small block and fall, the rope passing down and around the trolley, thus enabling it to be raised and lowered at will, or it may be hung on a swinging arm. The flow of sand is governed by the valve placed immediately below the bucket.

A tank of about 60 gallons capacity, provided with a pressure gauge, should be located in the cleaning room. The main air pipe is tapped and a 1-inch pipe led from it to the tank. Immediately before entering the tank a globe valve is placed, within easy reach of the operator, and by this valve the amount of air entering the tank is governed, only enough being allowed to enter to maintain the volume and pressure required for the sand blast machine. The outlet from the tank should be 2-inch, the air hose on the machine being connected thereto. At a convenient point in the room a $\frac{3}{8}$ -inch hole is tapped in the air pipe and the hose on the operator's helmet connected. A chilled mouthpiece is provided to take the wear of the sand at the nozzle.

The address of the King Improved Sand Blast Co. is Station C., Detroit, Michigan.

"DOUBLE END" CONSOLIDATION LOCOMOTIVE.

Dominion Coal Co., Cape Breton.

Built by the Schenectady Locomotive Works.

There is nothing new in the idea of double end locomotives for such service as that of the Sidney & Louisburg Railway for the Dominion Coal Co., but the one which we illustrate is be-

General Dimensions.

Gauge.....	4 ft. 8½ in.
Fuel.....	Bituminous coal
Weight in working order.....	239,000 lbs.
Weight on drivers.....	170,000 lbs.
Wheel base, driving.....	15 ft. — in.
Wheel base, rigid.....	15 ft. — in.
Wheel base, total.....	36 ft. 3 in.

Cylinders.

Diameter of cylinders.....	22 in.
Stroke of piston.....	28 in.
Horizontal thickness of piston.....	5½ in.
Diameter of piston rod.....	3¼ in.
Kind of piston packing.....	Cast iron
Size of steam ports.....	18 in. by 1¼ in.
Size of exhaust ports.....	18 in. by 2¼ in.
Size of bridges.....	1½ in.

Valves.

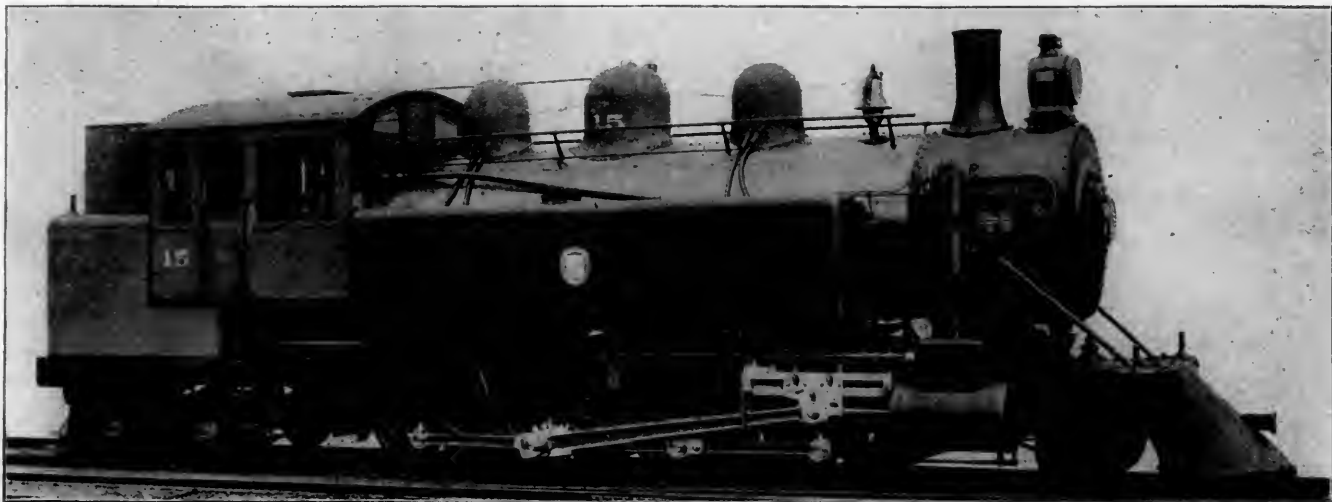
Greatest travel of slide valves.....	5½ in.
Outside lap of slide valves.....	¾ in.
Inside lap of slide valves.....	1/32 in.
Lead of valves in full gear.....	1/16 in.

Wheels, Etc.

Diameter of driving wheels outside of tire.....	55 in.
Material of driving wheel centers.....	Main, cast steel; intermediate, forward and back steeled cast iron
Driving box material.....	Main, cast steel; intermediate, forward and back, steeled cast iron
Diameter and length of driving journals.....	Main only 9 in. dia. 8½ in. dia. by 10 in.
Diameter and length of main crank pin journals.....	(Main side 7¼ in. by 5 in.) 7 in. dia. by 6½ in.
Diameter and length of side rod crank pin journals.....	(F. & B. 5 in. by 3½ in.) inter. 6 in. dia. by 4½ in.
Engine truck, kind.....	Two-wheel swing bolster
Engine truck journals.....	6 in. dia. by 10 in.
Diameter of engine truck wheels.....	30 in.

Boiler.

Style.....	Straight
Outside diameter of first ring.....	72 in.
Working pressure.....	200 lbs.
Thickness of plates in barrel and outside of firebox.....	23/32 in.
Firebox, length.....	9/16 in. ½ in. and 11/16 in.
Firebox, width.....	251/2 in.
Firebox, depth.....	F. 70¼ in. B. 67½ in.
Firebox plates, thickness.....	Sides 5/16 in. back 5/16 in. crown ¾ in. tube sheet ½ in.
Firebox water space.....	Front 4 in., sides 3½ in., back 3½ in. and 4 in.
Firebox, crown staying.....	Radial stays, 1½ in. dia.
Firebox stay bolts.....	1 in. dia.
Tubes, number of.....	348



"Double End" Consolidation Locomotive.

Dominion Coal Company, Cape Breton.

Built by THE SCHENECTADY LOCOMOTIVE WORKS.

lieved to be among the largest of this type ever constructed. These engines were designed to conform to the particular conditions of this service and they are powerful and heavy. Photographs of mogul and consolidation types have been received, but we show only the consolidation, as it is much heavier and larger than the other.

The cylinders are 22x28 inches, the boiler is 72 inches in diameter, with 2689 square feet of heating surface and 33 square feet of grate area. The total weight is 239,000 lbs., and the weight on drivers is 170,000 lbs. The engine is large and powerful, but large coal and water-carrying capacity is not needed, as the runs are probably comparatively short. The engines have gone into service and the reports of their performances are very satisfactory. They are equipped with American brakes, Leach sanders and Star chime whistles. The leading dimensions are given in the following table:

Tubes, diameter.....	2 in.
Tubes, length over tube sheets.....	13 ft. 10 in.
Fire brick, supported on.....	Studs
Heating surface, tubes.....	2,512.55 sq. ft.
Heating surface, firebox.....	176.92 sq. ft.
Heating surface, total.....	2,689.47 sq. ft.
Grate surface.....	33.21 sq. ft.
Grate, style.....	Rocking
Ash pan, style.....	Sectional, damper front and back
Exhaust pipes.....	Single, high
Exhaust nozzles.....	5¼ in., 5½ in., 5¾ in. dia.
Smoke stack, inside diameter.....	16 in.
Smoke stack, top above rail.....	14 ft. 9 9/16 in.

Tender.

Wheels, number of.....	4
Wheels, diameter.....	28 in.
Journals, diameter and length.....	5 in. dia. by 9 in.
Trucks.....	Four-wheel, center-bearing, swing-spring bolster carrying back end of engine
Water capacity.....	4,200 U. S. gallons
Coal capacity.....	4 tons

PERSONALS.

Mr. Lucius Tuttle, President of the Boston & Maine, has been elected President of the Maine Central also, to succeed Mr. F. A. Wilson.

William H. Smith, for several years Purchasing Agent of the Schenectady Locomotive Works, died at his home in Schenectady, N. Y., Oct. 14.

Mr. Rollin H. Wilbur, General Superintendent of the Lehigh Valley, has removed his headquarters from South Bethlehem, Pa., to 26 Cortlandt street, New York.

Mr. W. C. Alderson, Purchasing Agent of the Lehigh Valley, has been promoted to the position of Treasurer of the company, to succeed Mr. J. A. Harris, resigned.

Mr. James A. Gaston has resigned as Master Car Builder of the Louisville, Evansville & St. Louis, to take the management of the Bryant Paint Co. at Cincinnati.

Mr. George F. Evans has severed his connection with the Westinghouse interests, having resigned as manager of the Westinghouse Manufacturing Company, Ltd., Canada.

Elbridge G. Allen, who was General Superintendent of the Old Colony Railroad from 1893 to May 1, 1898, shot and killed himself at the Grand Union Hotel, New York City, recently.

Mr. S. F. Forbes, Purchasing Agent of the Great Northern, has resigned, to accept the position of Assistant Superintendent of Motive Power of the Central Railroad of New Jersey, with office in Jersey City.

Mr. Charles P. Coleman has been appointed Purchasing Agent of the Lehigh Valley Railroad, with headquarters at Philadelphia, Pa. He was formerly purchasing agent of the Bethlehem Iron Company.

Mr. A. C. Henry, Purchasing Agent of the Canadian Pacific at Montreal, has been appointed General Purchasing Agent of the entire system, and Mr. E. N. Bender has been appointed Assistant Purchasing Agent.

Mr. George W. Smith, Superintendent of Machinery of the Santa Fe Pacific, has had his jurisdiction extended to include the San Francisco & San Joaquin Valley. His office will remain at Albuquerque, New Mexico.

Mr. G. F. Jones, who has for 14 years held the position of Secretary of the Richmond Locomotive Machine Works, has resigned and accepted the position of Southern Representative of the Baldwin Locomotive Works, with headquarters in Richmond, Va.

Mr. Alfred Lovell, who has been connected with the motive power department of the Northern Pacific for a number of years, and was recently made Assistant Superintendent of Motive Power, has just been appointed to succeed Mr. William Forsyth as Superintendent of Motive Power.

Mr. J. W. Taylor was appointed secretary of the Western Railway Club at the September meeting, to succeed Mr. F. M. Whyte, who resigned upon his removal from Chicago to become mechanical engineer of the New York Central. Mr. Taylor is now also secretary of the Master Car Builders' and Master Mechanics' Associations.

Mr. Harvey Middleton, Mechanical Superintendent of the Baltimore and Ohio Railroad, has tendered his resignation. Mr. Middleton began railroading in 1876, with the Philadelphia & Erie, and has since held the positions of Master Mechanic on the Louisville & Nashville, Superintendent of Machinery

on the Atchison, Topeka & Santa Fe, Superintendent of Motive Power of the Union Pacific, and Superintendent of Construction of Pullman's Palace Car Co. He was appointed several years ago to succeed Mr. Geo. B. Hazlehurst, on the Baltimore & Ohio, and has done very important work in introducing heavy motive power and improving the arrangements of the shops of the road.

Mr. Robert C. Blackall, according to an official circular just received, has retired from active service as Superintendent of Motive Power of the Delaware & Hudson Co., and is appointed Consulting Mechanical Superintendent. The duties of Superintendent of Motive Power will be performed by Mr. J. R. Slack, Assistant Superintendent of Motive Power, with headquarters at Albany, N. Y.

Mr. W. I. Allen, who has for nine years held the position of Assistant General Manager of the Chicago, Rock Island & Pacific, has resigned in order to devote his entire attention to his private interests. The jurisdiction of Mr. A. J. Hitt, General Superintendent of the lines east of the Missouri River, has been extended over the entire system and the position of Assistant General Manager has been abolished.

Mr. Roswell Miller, the retiring President of the Chicago, Milwaukee & St. Paul, was at a recent meeting of the stockholders made Chairman of the Board. Mr. Miller began his railroad career with the Cairo & Vincennes, of which he was Secretary and General Superintendent. In 1882 he was Second Vice-President and Treasurer of the Chicago & Western Indiana. From there Mr. Miller went to the C., M. & St. P. as Assistant to the General Manager, and later was made General Manager and finally President.

Mr. Charles P. Clark, President of the New York, New Haven & Hartford, has tendered his resignation on account of continued ill health. When the matter came before the Board of Directors no definite action was taken and it is uncertain when the resignation will go into effect. Mr. Clark has had a long and very successful career. Much of the burden of the consolidations which have produced the present large system operated as the New York, New Haven & Hartford Railroad, was carried by him, and he also conducted a number of large enterprises, such as the track elevation in Boston and the consummation of the improvements at the Boston terminal. He has earned a rest from his arduous labors.

Mr. J. N. Barr has resigned as Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul to become Mechanical Superintendent of the Baltimore & Ohio, to succeed Mr. Harvey Middleton, who has resigned. Mr. Barr is a graduate of Lehigh University. He entered railroad service with the Pennsylvania at Altoona and after working up to an important position in the shops there he was appointed Mechanical Engineer of the Chicago, Milwaukee & St. Paul in 1885. In 1886 he was appointed Superintendent of the Car Department of that road and in 1888 he became Superintendent of Motive Power, which position he has held until the present. Mr. Barr is one of the strong men in motive power matters, to which the excellent condition of the motive power of the St. Paul road testifies. His most important work, aside from the generally good administration of the department, has been in the development and improvement of the chilled cast-iron wheel. As the inventor of the Barr contracting chill he has exerted a wide influence in the safety of railroad operation, which began before he left Altoona. He has invented a number of minor parts in car and locomotive construction and is recognized as a leader in the application of engineering, combined with common sense, to the management of the motive power department. He takes a wide, successful and well-seasoned experience to his new position and is a valuable acquisition to the staff of the Baltimore & Ohio.

THE CLIMAX FLEXIBLE METALLIC JOINT.

The accompanying engravings illustrate a simple, strong and inexpensive metallic joint for use in steam-heat equipment for trains, and also in stations and yards for making steam connections with cars for the purpose of heating them up before the attachment of the locomotive. The engravings show the exterior appearance of a joint for connecting a locomotive and tender, and it will be seen that no bolts are used.



A Climax Double Joint.

It is stated that the joint becomes tighter with the increase of pressure, and that it will work without leakage when comparatively loose. In a locomotive conduit two double and one single joint are used. They are made entirely of steam metal and appear to be strong and durable. There does not appear to be any possibility for oil, hot ashes or dirt to affect the life of these joints. The two portions of the swinging joint are held together by a sleeve coupling with flanges bearing against packing washers of durable material. One of these flanges is a part of the sleeve and the other is threaded and



Application of Joint Between Engine and Tender.

secured after the proper adjustment is made. A similar joint has been in use for several years in service severe enough to give confidence in its wearing qualities. One of the strong features is the relatively low cost at which this joint is sold. It is offered for sale by Mr. F. G. Street, 535 Temple Court Building, Chicago, Ill.

THE GABRIEL STAY-BOLT CHUCK.

In the report of the committee on "Best Method of Applying Stay-Bolts to Locomotive Boilers," presented to the Master Mechanics' Association at the recent convention, considerable

attention was given to the manner of screwing the bolts into the sheets. The report illustrates several methods, those in which the ends of the bolts are squared to receive a wrench and others in which the end of the bolt is entered into a clutch which grips the bolt tightly enough to turn it into place without specially preparing the end for the purpose. In the discus-



Gabriel Stay-bolt Chuck.

sion, a device of this kind used on the Pennsylvania Railroad was described.

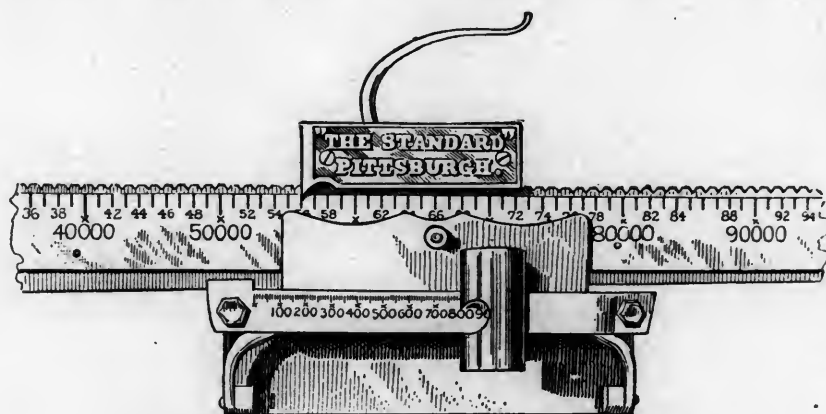
The accompanying engraving illustrates a newly patented device of this kind, known as the "Gabriel Stay-Bolt Chuck," which is manufactured and sold by the Chicago Pneumatic Tool Company, 634 Monadnock Building, Chicago. This chuck is shown in use in connection with the Boyer piston air drill. The chuck is arranged to grasp stay-bolts of any of the usual sizes, and it will turn them into the sheets without squaring up the ends. When driven by the air motor this work is done very rapidly, with a great saving of labor over the usual method of turning them in by hand.

Progress in the use of paint spraying machines was one of the subjects discussed by the Master Car and Locomotive Painters' Association at its recent convention. The prevailing opinion was that little progress had been made during the year. One member stated that difficulty had been experienced because at times the air is damp and the pressure from yard piping was not uniform on account of the variation in the demands for air. Another member stated that from a test on 573 cars, comparing the spray with brush work, he had found that the brush increased the cost of labor by \$186.22 over that of spraying, whereas the increase in the cost of paint due to the sprayer was \$489.91.

REED RECORDING ATTACHMENT

For Railroad Track Scales.

This is a simple appliance for the purpose of obtaining a permanent and positive record of the reading of a scale of the railroad track type. With it the weight may be taken with or without reading the beam. The accompanying engraving illustrates a track scale bearing this attachment. The main



Reed Recording Attachment for Railroad Track Scales.

beam is graduated by 1,000-pound marks and the small beam by 10-pound marks up to 1,000 pounds, the sliding poises being as free to move as without the attachment. The beam is notched in the usual way and in the beam puncturing pins are placed at intervals on an incline to correspond with lines of figures printed on a card which has headings to record the car number, marked weight, contents and the date of weighing. The large poise carries a card holder and the small poise has a brass casting and a puncturing pin which extends back of the card holder. After the beam is balanced the holder is pressed toward the beam and the recording pins puncture the card and supply the permanent record of the locations of the poises. One movement records the total weight of the load, and the card holder is the only additional movable part which this device adds to a scale. The correct weight may be had in less time than is required to read the beam. The device is in use by about 25

Card No. _____ Date, _____ 189 _____ Gross _____ lbs.
 Mark Weight, _____ 189 _____ Tare, _____ "
 Contents, _____ Net, _____ "

REED RECORDING ATTACHMENT. SUPERINTENDENT OR R. R. REED. PATENT APPLIED FOR.

190	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119
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The Standard Scale & Supply Co. Limited, Manufacturers, Pittsburgh, Pa., U. S. A.

1000 900 800 700 600 500 400 300 200 100

Record Card Reduced to About Half Size.

prominent furnaces and steel concerns and also by a number of railroads, a list of which will be printed in a future reference to this device in our next issue. We have seen letters from officers of several of these roads expressing satisfaction with the device. It is manufactured and sold by the Standard Scale & Supply Company, Ltd., 211 Wood Street, Pittsburgh, Pa.

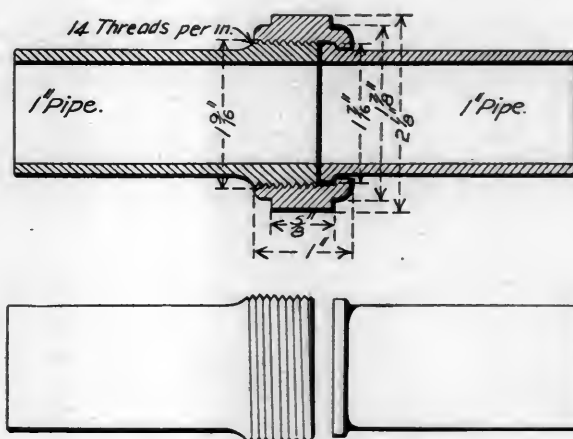
Two more compound locomotives of the tandem type, on the plan patented by Mr. John Player, Superintendent of Motive Power of the Atchison, Topeka & Santa Fe, are to be built at the Topeka shops of that road. These are to be in accordance with the system illustrated and described in our issue of June, 1899, page 211. They are to have 77-inch driving wheels and will be used in passenger service. The reports of the performance of this type of locomotive on this road appear to continue to be favorable.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

On Wednesday, September 27, the exercises of the Massachusetts Institute of Technology began. Since the end of the last term some changes have been made in the faculty. Adolph Rambeau, Ph. D., has been made Professor of Modern Languages, and has charge of that department. Arthur A. Noyes, Ph. D., formerly Associate Professor of Organic Chemistry, has been made Professor of Theoretical and Organic Chemistry. Jerome Sondericker, C. E., formerly Assistant Professor of Applied Mechanics, has been made Associate Professor of Applied Mechanics; Allyne L. Merrill, S. B., formerly Assistant Professor of Mechanism, has been made Associate Professor of Mechanism; Edward F. Miller, S. B., who was Assistant Professor of Steam Engineering, has been made Associate Professor of Steam Engineering; Carleton A. Read, S. B., who was an Instructor in Mechanical Engineering, has left to take charge of the Mechanical Engineering Department in the New Hampshire College at Durham; George V. Wendell, Ph. D., has returned from three years' study in Germany and resumes his duties as Instructor in Physics; Frederic H. Keyes, S. B., and Alexander W. Moseley, S. B., have left to take up professional work; Frederick A. Hannah, S. B., has accepted a position in the Mechanical Department of the Brooklyn Polytechnic Institute.

PIPE UNIONS MADE DIRECTLY ON THE END OF THE PIPE.

The accompanying engraving illustrates a new pipe union devised by Mr. T. R. Browne, Master Mechanic of the Juniata shops of the Pennsylvania Railroad at Altoona. The first glance at the sketch shows the clear opening through the joint, which is entirely free from obstruction. This is not true of the ordinary commercial unions. These new unions are made by a very simple process on a bolt header by use of a pair of dies. In each case the external die is formed to the shape of the finished piece. The internal die consists merely of a plunger



Union Made on the End of Pipes.

of two diameters, the larger representing the larger diameter of the union and the smaller diameter corresponding with the inside diameter of the pipe. The dies are so made that before any upsetting takes place on the pipe the internal die has entered the external die in such a way as to form a closed or solid die. This method permits of the use of the next smaller size of standard union nut than would be used with the standard union. For example, for a 1-inch union made in this way a standard nut for a 3/4-inch union may be used. These unions are very simple and neat and they possess the advantage of reducing the number of joints and opportunities for leakage, as well as making a very strong joint.

THE "MONARCH" PNEUMATIC HAMMER.

The accompanying engraving shows the appearance of the "Monarch" pneumatic hammer recently placed on the market by the Standard Railway Equipment Company, 210 Vine Street, St. Louis. The company is interested in other pneumatic tools, but particular attention is now being given to two sizes of pneumatic hammers. These are designated as style "A" and



The Monarch Pneumatic Hammer.

style "B." The former is for light work, such as caulking, flue beading and light chipping, while the latter is for heavier work about the construction of boilers, where a heavier hammer is required. The ferrules of these hammers are either round or hexagonal. It is claimed by the manufacturers that these hammers are very economical in the use of air and that while they strike hard blows the plungers are cushioned in such a way as to reduce the vibration to a minimum. The ports in the cylinder are so arranged as to prevent the hammer from operating when the chisel is removed from the shank. The valve is very simple and is made of hardened steel. A strong claim is made for their satisfactory operation without derangement. The Standard Railway Supply Company states that these hammers will be furnished on 10 days trial to those desiring to test their qualities.

FRICTION SENSITIVE DRILL.

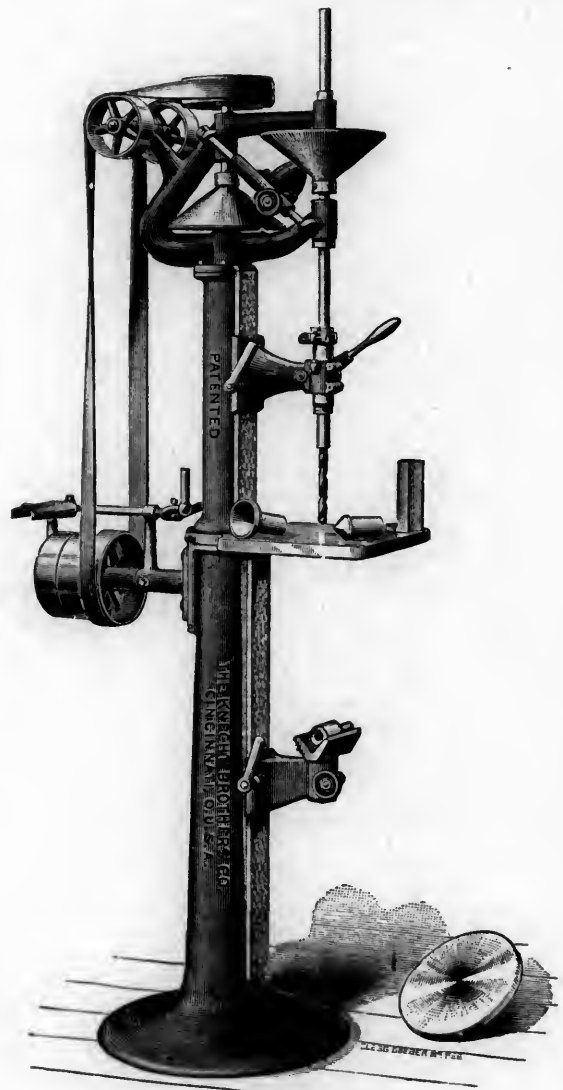
Knecht Brothers Company, Cincinnati, O.

It is evident that an unusual amount of thought and experience has been applied to the development of this machine. Our attention was called to it by a letter from Mr. David Hawskworth, the well-known Superintendent of Motive Power of the Burlington & Missouri River Railroad, in which he said: "The drill is giving entire satisfaction and you may refer any prospective purchaser to me."

The driving mechanism consists of two cones with a friction roller bearing between them, the roller being adjustable in position for the purpose of changing the speed of the spindle. This may be done while the machine is running and without changing or shifting belts. The range of adjustment is $4\frac{1}{2}$ inches, which is sufficient to provide for drills from the smallest up to a diameter of $\frac{9}{16}$ inch. The power varies as the speed is changed and it, and also the speed, is adjusted for each size of drill by means of a graduated bar upon which the journals of the friction roller are supported. This bar is marked for the different sizes of drills. A screw clamps the roller in the desired position and the speed may be adjusted accurately by the marks on this bar. The necessity for varying the power of a machine of this kind is obvious. The presence of hard spots in the work causes trouble with drill presses which are not sufficiently sensitive. In this machine the pressure of the friction roller between the two cones may be adjusted very finely by turning the hand adjusting nut under the lower driving cone enough to give the power required to turn the drill that is to be used. In case the drill should bind or be strained by imperfections in the material the driving mechanism will slip and afford relief by stopping the drill. This adjustment is within easy reach of the operator. The depth to be drilled is indicated by graduations on the sleeve passing through the

spindle head and a stop collar is placed on the spindle sleeve which may be set for any desired depth of hole, or it may be removed entirely by turning out the binding screw. This collar may be set so as to drill any desired number of holes to a fixed and uniform depth without reference to the graduation on the sleeve. The attachments and adjustments are all within easy reach of the operator from the front of the machine.

The spindle is relieved from lateral pressure by the mounting. The cone driving the spindle is mounted on a sleeve or bushing which extends through both bearings in the frame, and the spindle may be run continuously without danger of heat-



The Knecht Sensitive Drill.

ing. This spindle sleeve has ball thrust bearings. The machine is driven by a belt, the slack or stretch of which may be taken up by moving the countershaft bearing down on the column and securing it by means of a small adjusting screw in the slot in the column. The drill press has a square and a round table swinging on the column so as to be easily turned out of the way when the drill is to be applied to work held in the knee below. This knee is fitted with a number of attachments for receiving work of various shapes. It has a cup center for drilling the ends of shafts and mandrels, a center point, and a V-shaped block with a stem for drilling shafts at right angles with their axes.

The distance from the column to the center of the spindle is $6\frac{1}{2}$ inches; the maximum distance from the end of the spindle to the table is 28 inches; the vertical adjustment of the spindle head 13 inches; the throw of the spindle is $3\frac{15}{16}$ inches. The floor space required is 20 by 34 inches, and the speed of the countershaft is 460 revolutions per minute. The manufacturers, the Knecht Brothers Company, Cincinnati, Ohio, may be addressed for further information.

BOOKS AND PAMPHLETS.

Poor's Manual of the Railroads of the United States, 32d Annual Volume, with an Appendix containing a full Analysis of the Debts of the United States, the several States, Municipalities, etc.; also Statements of Street Railroad and Traction Companies, Industrial Corporations, etc. New York: H. V. & H. W. Poor, 44 Broad St. 1899. Price, \$7.50.

We have just received the 32d annual number of Poor's Manual, in which is given, in great detail, statistics of the financial condition and results of operation of all railroads in the United States. Our readers do not need to be told what this indispensable work contains. It is sufficient to say that it is brought up to date in the present volume with the addition of important information which was not given in former editions. The object of this publication for a number of years was to give the public a faithful abstract of the reports of the railroads and to supply the lack of such government summaries of the operation of American railroads as are given in the Board of Trade Reports on British Railroads. This information is now collected by the Interstate Commerce Commission, but the reports are not published until at least a year later than Poor's Manual. Every one who has occasion to use railroad statistics fully understands the value of promptness in their publication. The volume before us includes a new feature, a chapter in the introduction entitled "A Study in Railway Statistics," which is a review of the statistics of the development, finances, etc., of the railroads of this country, with special reference to the period from 1880 to 1889. In this chapter will be found an account of the beginnings of the railroads and a statement showing, by states and groups of states, the terminal points and mileage of all railroads which were completed and in operation in the United States in 1840. We believe this information to be very valuable and it has not before been available. Its compilation must have been exceedingly difficult. In this chapter a table gives the mileage in operation in 1851, with the passenger, freight and total earnings. Another gives the annual progress in railroad construction in the whole country between the years 1849 and 1860. Another table, of historic value, gives the termini of the first section of each road opened, the length of the section and date of opening. These new features will undoubtedly be appreciated. There appear to be no other new departures, although the entire work must necessarily improve in completeness each year as a result of the careful methods of the publishers.

U. Baird Machinery Company.—A comprehensive and well arranged catalogue has been received from the U. Baird Machinery Company, Pittsburgh, Pa. It has 232 pages, standard size (9 by 12 inches), and is well printed, the descriptions being supplemented by uniformly good engravings. The paper, type and printing are also excellent. The descriptions are in four languages, English, German, French and Spanish, and dimensions are given in English and metric systems. Code words (Lieber Code) are given in connection with all of the specialties described. A large amount of space, 33 pages, is devoted to engine lathes; this subject is followed by planers, turret lathes, punches and shears, boring and turning mills, upright drills, universal hand milling machine, cranes (25 pages), air hoists and trolleys, portable motor, belt and steam-driven air compressors for light and heavy work, high altitude air compressors, mine compressors, compound steam compressors, pneumatic riveters, sprue cutters, magnetic chucks (for planers, shapers and grinders), rotary chucks, dynamos, twist drills, reamers, lathe dogs, tool grinders and pneumatic drilling and tapping machines. The catalogue closes with a series of tables comparing the metric and English units, which is followed by an index in the four languages used in all the descriptive matter. The catalogue is a convenient one for purchasers in this country and it is specially adapted to the requirements of foreigners. It is evident that this company appreciates a very important item in securing foreign trade, that of presenting information in the language and system of measurement used in other countries. The catalogue is from the Chasmer-Winchell Press.

The Joseph Dixon Crucible Co. have distributed a new pamphlet of 20 pages (not standard size) concerning the use of Dixon's Ticonderoga Flake Graphite for cylinders and valves. Some of the information it contains has been issued in previous pamphlets; the one before us, however, combines the information concerning the lubrication of valves and cylinders with graphite. Graphite is strongly recommended in cases of high

temperature and superheating, where oil is more or less troublesome on account of the effects of the high temperatures. Graphite is recommended for use in giving "body" to mineral oils, and it is not affected by the highest temperatures used. Its satisfactory action appears to be due to the filling up of minute inequalities in the bearing surfaces, making an ideally smooth surface. The pamphlet contains information concerning graphite and includes a large number of letters received from engineers who have used it successfully.

The Boston Belting Company have issued a handsome little pamphlet of 24 pages from the Barta Press, Boston, entitled "Suggestions." It contains interesting information about the history and origin of rubber manufacture with these works in 1828, the development of the large field filled by manufactured rubber goods and the impression given is that anyone desiring India rubber goods of any description will do well to consult these manufacturers. An excellent idea of the method of collecting the raw material is presented by a series of attractive illustrations with explanatory captions. A printed list of 75 items gives a good idea of the large number of different rubber specialties made by this concern. Copies of this attractive pamphlet may be had by addressing the Boston Belting Company, 256 Devonshire St., Boston, Mass.

EQUIPMENT AND MANUFACTURING NOTES.

The Q and C Co. announce that they have arranged for the exclusive control of the sale of "Magnolia Anti-Friction Metal" to the steam and electric railroads of the United States, Canada and Mexico.

The McConway & Torley Co. have an exhibit in the railroad annex at the Philadelphia Export Exposition consisting of the Janney standard coupler and a Buhoup three-stem freight coupler.

The Joseph Dixon Crucible Co. have an exhibit of their graphite productions at the National Export Exposition, Philadelphia. It is located in the southern end of the main exhibition hall, Section M-7. Our readers are invited to visit it.

The National Electric Car Lighting Co. of 100 Broadway, New York, who have developed the "Axle Light" system for railroad cars, have sold and transferred their entire assets and patent rights to the Electric Axle-Light and Power Co. The new company will continue the business and develop it. All communications should be addressed to the Electric Axle-Light and Power Co., 100 Broadway, New York. Mr. Max E. Schmidt continues in the management of the enterprise.

The Schoen Pressed Steel Car Co. is exhibiting three steel cars at the Export Exposition in Philadelphia. The first is a double hopper gondola of the Pennsylvania Railroad of 100,000 lbs. capacity, weighing 39,400 lbs. There is also an 80,000 lbs. flat floor gondola from the Union Pacific, weighing 31,500 lbs., and a 100,000 lbs. flat car of the North Shore Terminal R. R. weighing 25,800 lbs. This car has a steel deck. The cars are well located and will attract the attention of foreigners attending the Exposition. They constitute one of the most representative exhibits of new American industry.

The Chicago Pneumatic Tool Company has secured the services of Mr. C. E. Walker, who has been for the past five years Master Mechanic of the Baltimore & Ohio Southwestern Railway, at Washington, Indiana, as their representative in Cincinnati. Mr. Walker served as apprentice in the machinist's trade at the National Locomotive Works, Connellsville, Pa. In 1879 he entered the service of the C. B. & Q. R. R., and has been promoted steadily. He will attend to the interests of the Chicago Pneumatic Tool Company in Cincinnati and the contiguous territory. His familiarity with railroad shop practice renders him a valuable addition to the staff he now enters.

The Magnolia Metal Co. announce that the Q & C Co., of Chicago and New York, have become the exclusive agents for the sale of Magnolia metal to the railroads of the United States, Canada and Mexico, and that the Metal Sales Co., 15 South Water street, Cleveland, Ohio, have been appointed sole agents for Ohio, Indiana and Michigan.

The Union Boiler Tube Cleaner Company of 253 Penn Avenue, Pittsburgh, Pa., has recently finished the largest contract ever awarded for cleaning boilers, being for twenty-two water-tube boilers, containing an aggregate of ten miles of four-inch tubes, a task which we believe no other concern in the world has the equipment to accomplish. They have just shipped their eighth machine to Great Britain. The initial machine for export had been shipped just one year previously. One of the latter was a repetition of the first order.

The Chicago Pneumatic Tool Company writes that the ten new Boyer pneumatic riveting hammers with long stroke, which have been in use for some time at the works of the Pressed Steel Car Company at Allegheny, have proven so satisfactory as to lead to an order for 60 more. These hammers are used for riveting in the construction of steel cars, and they have shown themselves to be durable and rapid, effecting a marked saving of labor and contributing to increasing the productive capacity of the works. They were selected as a result of severe service tests and this substantial order indicates the success which they have made. We are informed that orders for these hammers are already taxing the facilities of the manufacturers to turn them out.

We are informed that a bale of Zelnicker's "Dynamo" waste will be sent on trial to those who desire to try it practically. We have before directed attention to the fact that Mr. Zelnicker is a manufacturer and agent for mill and shop supplies, including engines, boilers and machinery. He is prepared to furnish everything used in the construction, operation and maintenance of railroad shops, and among his specialties is the "Zelnicker Prepared Roofing," which is strongly recommended for round-houses and warehouses. He makes a specialty of second growth hickory maul and hammer handles. He is agent for the "Positive" nut lock washers, the Cyrus Roberts hand and push cars, the Johnston wrench, and for the product of the Trenton Iron Works. His address is 202 North Third St., St. Louis, Mo.

Two new blast furnaces having a capacity of 1,400 tons of iron per day will be added to the plant of the Carnegie Steel Company, Limited, on the site of the Carnegie-Carrle furnace property, directly across the river from the Homestead plant, and a double-track steel railroad bridge will be built across the river at this point. The melted iron will be run across the river in ladle cars, for use in open-hearth steel making, or in Bessemer converters. The Duquesne plant is also to be enlarged by the addition of an open-hearth steel plant and a reversible blooming mill. The estimated cost of the improvements is between \$7,500,000 and \$8,000,000. This is a satisfactory indication of the opinion of the Carnegie people that the present activity in the iron and steel business is to continue.

The Ajax Metal Co. of Philadelphia are adding to their testing department one of the very latest improved testing machines, and in future they will not only be able to make analytical and microscopic tests, but also physical tests, such as to bring out friction, wearing and compressive qualities. In other words, they propose to make practical tests of all material entering into the journal boxes used in railroad service, which will consist of bearing metals, oil and waste. These demonstrations will be published in the trade papers as they progress, using standards of all material in comparison, taking those that are largely used in the service, and those that are not but should be used. Mr. J. G. Hendrickson, president of the company, is thoroughly familiar with the lubricating qualities of oils, having been connected with the Standard Oil Co. prior to taking up the metal business. The Ajax Metal Co. will be pleased to correspond with all who are interested.

The exhibit of the Standard Wheel Works at the Export Exposition now open in Philadelphia includes an interesting variety of wheels and steel tires of their manufacture. A 78-inch locomotive tire attracts attention, and while not the largest in use in this country it is an example of good workmanship and material in a very large wheel. The wheels shown include a 24-inch wrought spoke center, a 34½-inch wrought spoke center with bolted tire connection, a 36½-inch cast iron plate center wheel with steel tire, a 30-inch cast iron center wheel for the "Big Four," a 72-inch cast steel driving wheel center, a 42-inch spoke center steel tired wheel for the Moscow, Kieff & Veronesm

Ry., and a 42-inch cast center wheel for the Chicago & Northwestern Ry. The steel castings are admirable examples of sound and smooth work which should add to the confidence in cast steel as it is now made by the best manufacturers.

Cling-Surface is a name becoming very well known in the manufacturing world, if inquiries and business success are an indication. The Cling-Surface Mfg. Co., of 123-129 Virginia St., Buffalo, N. Y., report that they have just established a branch in Johannesburg, South Africa, to meet the increased demand for Cling-Surface in that section from those who have been compelled to run their belts as tight as possible to prevent slipping. A recent letter from a prominent mechanical engineer says: "Being somewhat skeptical as to the virtue of any belt dressing, it was some time before I concluded to try Cling-Surface, and only after being driven to it, as our belts were badly overloaded and showed signs of rapid depreciation. Your Cling-Surface was a complete revelation to me, and belts that formerly had to be run so tight as to cause a great deal of noise are now running slack and quiet, with not the least evidence of slipping. I heartily recommend it for leather belting, for in addition to its increasing the pulling capacity of a belt, I find the belts are soft and show a fine, glossy, yet very clinging surface."

The Bullock Electric Manufacturing Company of Cincinnati reports sales for the month of September involving sixty-one machines ranging in size from three to one hundred and fifty kilowatts. Among the more important were fifteen engine-type generators for United States Army transports and ten 50-horse-power motors to operate at 200 R. P. M., for Messrs. Dick, Kerr & Co. of London, England. Several repeat orders were received, among them being the following: Maryland Steel Company, Baltimore, Md., third order; Consumers' Park Brewery, Brooklyn, N. Y., third order; Atlas Cement Company, Northampton, Pa., fifth order; Missouri Lead and Zinc Company, Joplin, Mo., third order. When representative concerns such as those named find it to their advantage to continually add to their equipment of Bullock apparatus it indicates that the machines have given perfect satisfaction. A new Bulletin, No. 2,345, just issued by the company, describes Type "N" motors. This is the first bulletin of the standard 6 by 9-inch size which has been issued. We believe those interested in electrical literature will appreciate this reduction in size, as it is more readily filed than the larger pamphlets. It may be had by addressing the company.

The J. G. Brill Co. have an exhibit of cars and trucks at the Export Exposition in Philadelphia. It is in the railroad annex and consists of one of the new convertible street cars, four trucks, including the "Perfect" truck, and a street sprinkling car. The convertible car is interesting and it appears to be a solution of the problem of combining the open summer car and the closed car for winter use in the same structure. The car has lateral seats and a center aisle. The frame posts are grooved to the floor and the car is closed at the sides by first drawing down the lower panels from their places under the headlining and then the sashes from the same place. The panels are of sheet copper on the outside and wood veneer on the inside with slats between, giving a flexible sheet which is easily slid down the grooves into place. The sash are in two parts, also carried in grooves, and when drawn down the car is closed. The fitting of the panels and sash is accurate and the appearance of the car is all that can be desired. Long curtains running in grooves separate from the siding and coming down to the floor complete the arrangement.

About \$20,000,000 represents the contracts for freight cars placed with the American Car & Foundry Co. since the middle of October. Among the largest orders received and accepted by the company this month were one from the New York Central system for 9,500 freight cars; from the Pennsylvania system, 3,500 freight cars; from the Lehigh Valley, 3,500 freight cars; the Missouri Pacific, 1,300 freight cars; the Norfolk & Western Railroad, 700 cars of various dimensions; the New York & New Haven, 500 cars, and the Delaware & Hudson Co., 300 freight cars. These contracts represent a total of about 17,000 cars, valued at more than \$14,000,000. Aside from these, several smaller contracts have been accepted. The above orders are only for the Eastern district. In the West within the last few days the company has received scattering orders for between \$2,000,000 and \$3,000,000 worth of business in addition.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

DECEMBER, 1899.

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AN AMERICAN OBSERVER ABROAD.*

III.—English Track.

By Prof. W. F. M. Goss.

I had heard much of English railway track. Its rigidity, the high degree of perfection attained in its maintenance, and the attention bestowed on its embankments have been so frequently referred to by Americans who have traveled in England that I had concluded that in these, and doubtless in many other respects, I should find English track to be far superior to that with which I had been familiar. This conclusion, moreover, had from time to time been re-enforced, by direct statements which I have heard, concerning the inferiority of American track.

There probably was a time when the average English track was better than that of America, but I deem it no disparagement of English track to say that this condition belongs not to the present, but to the past. The fact is, that American roads have made such wonderful progress in track design and maintenance that the result has quite outstripped the popular estimate.

English track is of the chair-type. The rail is double-headed, and having no flange or base upon which to stand, it is held in position by cast-iron chairs which in turn are bolted, or secured by spiking to wooden cross-ties. Years ago, rails which had become worn on one head were reversed in the chairs, and thus made to give service on both heads, but the practice has been abandoned since the adoption of steel rails; and as the weight of rail has increased, there has been an unequal development of heads, the lower one retaining dimensions which I imagine are but little changed from those of the iron rail, while the upper one has become larger.

The chairs in which the rails are held consist of a base from which two lugs rise to a height nearly equal to that of the rail. The bottom of the chair between the lugs gives support to the lower head of the rail, and the face of the inside lug bears upon the web of the rail, an oak key or "track-wedge" driven between the outside lug and the rail serving to maintain the latter in contact with the inside lug. The "wedges" are straight, but the outside lug is set at an angle with the rail so that the wedge tightens as it is driven. Joints in the rail

fall between two chairs, and are usually made with four-bolt splice-bars, the outside bar extending to the top of the rail.

The claim to greater rigidity appears to rest upon the use of the cast-iron chair. I make this statement because I was told in England that the chair was considered an element of rigidity and because I can find no other element to which superiority in this respect could possibly be ascribed. In the matter of ballasting, for example, I did not see in England anything which could approach in outward appearance the ballasting of hundreds of miles of road over which I have ridden in the United States. Where broken stone is employed it is often intermixed with other material, and is always laid with less uniformity than in the tracks of our better American roads. The ties, a most important element in giving rigidity to track, are more widely spaced than in American track, and the English rail cannot, I think, lay claim to superior stiffness.

Since, therefore, the claim for superior rigidity appears to rest in the use of the chair, some account of the manner in which this detail performs its function may be of interest. As a means for securing a good bearing on the tie, the chair is as good, but doubtless not better, than the tie plate common to American practice; as a fastening between rail and tie it has obvious defects. The movement of the rail under influence of temperature changes, and of passing trains, loosens the wedges which, on important curves, I am told, must be redriven every morning. The fact that in yards and about stations, one not infrequently sees wedges which have dropped completely out of the chair also justifies the belief that when apparently in place they are sometimes loose and hence of little effect. Moreover, the wedges are on the outside of the rail and even when they are well driven, it would seem that on curves, under the influence of heavy trains at speed, they must yield enough to allow some vibration in the rail. If this condition exists it would account in part for the bad riding of English carriages on curves.

These points, while briefly and incompletely stated, will be sufficient to show that the English rail-chair is an element permitting flexibility rather than tending toward rigidity. The truth is that the chair of to-day is an heritage from a period when conditions were quite different from those now existing, a fact which no one appreciates more fully than English railway men themselves, many of whom I am told look for the early introduction of "rails of the American section." The proposition, therefore, that the English track is more rigid than our own cannot, I think, be maintained. The reverse is true.

Whether the line and surface of rails are better preserved on English roads than on those of American roads, which are comparable with them, I cannot say, for an estimate based on experience in riding over the track is, in this case, unreliable on account of differences in the character of the equipment. Judging the result by the means at hand for securing it, it appears quite unlikely that the English standard of excellence is as high as that prescribed for first class track in America, for the American track has the advantage of better ballasting, more closely spaced ties, and an equally stiff and better supported rail.

Special work at crossings is in England generally far inferior to similar work at home, though in England such crossings are comparatively rare. The practice is to carry crossing-frogs and the rails in their vicinity on longitudinal stringers, the advantage of running long ties obliquely under such work either not being appreciated, or made difficult to obtain because of the use of the chair.

The English embankments are indeed more beautiful than the average embankment of America. First of all, the former have easier slopes and these better maintain their regularity of form. This is man's contribution to their beauty, all the rest is nature's work, for in England everything is green! Seeds thrown into the air seem to find there all the conditions necessary for their germination, and the embryo plants take hold wherever they chance to alight. The railway embank-

*For previous article see November issue, page 348.

ments have to be green; they cannot escape it. I saw them when all the landscape was not only fresh and green, but possessed a depth of color, the full beauty of which can only be appreciated by those who have seen an English landscape in early summer. It is enough to say of the embankments that they constitute no blemish in such a landscape. As a rule, no attempt is made to adorn them in an artistic way, either by the use of flowers or by the application of the lawnmower, as is frequently done in America; but still, the advantage is with the English embankments. Their green sides harmonize so perfectly with the hedge-rows and the willow-fringed streams, that the presence of the iron way is only a slightly marked intrusion on a peaceful rural scene.

The structures along the right-of-way have often been spoken of in terms of highest admiration, because of their permanent character. Most of them were made years ago when no one could foresee the requirements of to-day's traffic. The platforms, tunnels and overhead bridges prescribe a clearance gauge which requires the cross-section of English trains to be smaller than that of any other country using standard gauge road. American roads with clearances which used to be considered very liberal are now working close to their limits, and beginning to wish for more room; and it must be that the English, working within very much narrower limits have long ago realized something of the handicap which is upon them. It would, in fact, appear, that the very element of permanency which characterizes these structures is a serious obstacle to the progress of the roads. Viewed in the light of American experience, it amounts in many cases to a species of over-designing.

It should be noted that whatever defects may exist in English track are due chiefly to the presence of details which have descended through a long series of years, which in their day have served a good purpose well, and which must now be given time to disappear. Moreover, English track is, generally speaking, good, and hence not deserving criticism. The sole purport of this letter is to deny the commonly alleged inferiority of American track.

To evidence already presented I would add that since this letter was outlined, I have seen enough of the tracks of Continental Europe to convince me that Americans will do their country but justice and will take to themselves nothing, but deserved credit, if they refrain from awarding the palm in the matter of track to any country save their own. I doubt whether the track exists which is better in its road-beds, or in the details of its structure, or in the degree of perfection attained in keeping the rails to line and grade, than that which reaches out over thousands of miles in the United States.

The application of power brakes and automatic couplers in this country, according to the latest report of the Interstate Commerce Commission, stands as follows: Out of a total of 9,956 passenger locomotives, 9,845, or practically all, are fitted with train brake apparatus, and out of a total of 33,595 passenger cars 33,149 were so equipped at the end of June, 1898. Of the passenger locomotives 5,105 had automatic couplers and 32,697 passenger cars were thus equipped. In freight service 19,414 out of a total of 20,627 locomotives had train brakes and 6,229 had automatic couplers. Out of 1,248,826 freight cars, 567,409 had train brakes and 851,533 had automatic couplers.

The number of railroads in the hands of receivers has decreased by 34 during the year ending June 30, 1898, which is covered by the latest report of the Interstate Commerce Commission. During that year 11 roads went into the hands of receivers and 45 were removed from their management. There was a decrease of 6,116.73 in the operated mileage of this class of roads.

LOCOMOTIVE DESIGN.*

By F. J. Cole, Mechanical Engineer, Rogers Locomotive Works.

Strength of Flat Surfaces in Boilers.

It is often desirable to know the theoretical as well as the actual elastic strength of flat plates to resist steam or water pressure, under conditions similar to those of their use in steam boilers, in order to calculate, or ascertain, with a reasonable degree of accuracy, the pressure per square inch which will permanently set or bulge a flat plate for a given thickness, material, distance apart of stays, etc.

The demand for heavy engines of great tractive power has necessitated the use of high steam pressures, so that few new locomotive boilers are built to carry less than 180 pounds per square inch, and pressures of 200, 210 and 220 pounds are the rule rather than the exception.

In considering the strength of flat plates in boilers carrying the latter pressures, it seems more desirable to estimate their elastic strength to resist bulging, and from this to select a suitable factor of safety, than to trust entirely to empirical considerations and merely add a little to the strength of previous work, built for lower pressures, which appears to be safe for those known conditions.

Probably the most exhaustive investigations into the strength of flat stayed surfaces and the holding power of screw stays in iron, steel and copper plates, was made by Messrs.

Steel Plate—Iron Staybolts.

Staybolt heads shaped, with a buttonhead set, to spherical segments.

Thickness of plate.....	3/4 inch
Distance from center to center of staybolts.....	4 inches
Diameter of staybolts outside of threads.....	1 inch
Diameter of staybolts inside of threads.....	7/8 inch
Diameter of staybolt heads at base.....	1 1/4 inches
Height of staybolt heads.....	1 1/2 inch
No. of threads on staybolts per inch.....	12
No. of threads left projecting to form head.....	5
Tensile strength of each staybolt.....	32,476 pounds

Greatest bulge and permanent set of plate at different pressures, measured at points between staybolts.

Pressure.	Bulge.	Set.	Remarks.
Pounds.	Inches.	Inches.	
500	0	0	The first leaks appeared around the four central staybolts at 1,600 pounds; at 1,700 pounds the heads stripped from these bolts, and the others were damaged as shown in the drawing.
700	0	0	
900	0	0	
1,100	3/16	0	
1,300	5/16	1/16	
1,500	7/16	3/16	
1,600	1 1/16	1/2	
1,700	1 3/16	3/4	

Sprague and Tower for the Bureau of Steam Engineering. The report was published by the United States Government Printing Office in 1879. The experiments on screw staybolts and flat plates were arranged to represent a section of a firebox, and to imitate as nearly as possible the actual conditions existing in a boiler. Fig. 1 shows the apparatus used in the experiments. The ring was 4 inches deep, 18 inches internal and 23 inches external diameters, arranged with bolts so that the plate to be tested could be secured to one side of this ring. Stay bolts spaced from 4 by 4 inches to 8 by 8-inch centers were screwed through the plates and riveted over. Water was then pumped in through the opening, A, and the pressure required to produce permanent set or "bulge" in the plates carefully noted.

Table No. 1 was compiled from these tests, and summarizes the results of that part of the experiments referred to which relates to the strength of flat stayed plates when used under conditions similar to those in locomotive boilers and fireboxes. The results are somewhat erratic, permanent set occurring in some cases at much lower, and in others at much higher pressures than might have been expected. This is particularly the case with the 3/4-inch iron plates; the "set" occurred at 100 pounds, with 6 by 6-inch centers, and at 50 pounds with 7 by 7-inch centers. Probably if these tests

* For previous article see page 361.

TABLE No. 1.

U. S. Bureau of Steam Engineering, pressure in pounds per square inch to permanently set flat plates supported by staybolts.

Plates.		Center to center of staybolts.				
Thickness in inches.	Material.	4 x 4 in.	5 x 5 in.	6 x 6 in.	7 x 7 in.	8 x 8 in.
1/4	Iron.	900	325	100	50	.....
3/8	"	960	500	300	200	.....
1/2	"	1,060	800	700	260	.....
5/8	Steel.	700	200	125	250	100
3/4	"	1,100	500	500	300	.....
7/8	"	1,600	600	700	400	400
1	Copper.	300	160	.....	.....	.....
1 1/8	"	.....	350	100	.....	.....
1 1/4	"	.....	.....	300	200	.....

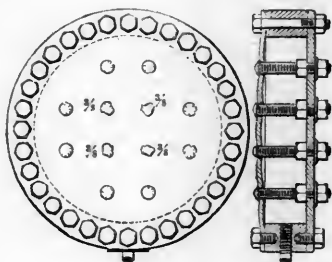


Fig. 1

had been repeated two or three times, many of the apparent inconsistencies would have disappeared in the average result. The staybolts used were nearly all 1-inch diameter in the bodies, with 1 1/4-inch diameter heads, formed like the segment of a sphere.

From an examination of the above table it will be noticed that the strength in a number of cases does not increase as the square of the thickness. Plates held rigidly at the edges in the manner described should apparently follow the same general laws as a rectangular beam firmly fixed at both ends and uniformly loaded, and the strength be proportionately greater than when merely supported at the ends or edges. (Figs. 2 and 3). The strength should also increase as the square of the thickness. It may be suggested, however, that when the plate is rigidly confined at the edges, either with or without stays, permanent set takes place by the stretching or pocketing of the plate between the staybolts. If a beam, made of material equally strong both in tension and compression, be merely supported, and not fixed at both ends, and loaded in the center, it will fail by compressing the fibers above and extending those below the neutral axis; therefore the beam will bend but will not increase in length. If it is firmly fixed at the end in a rigid support, it is evident that some lengthening of the beam must take place before it can take permanent set.

The following formula is suggested for flat stayed plates. While it observes the generally accepted and established laws regarding the thickness, it also gives average results closely agreeing with the foregoing experiments and tests:

$$S = 1.5 \frac{E t^2}{(d - a)^2}$$

In which:

S = maximum stress to permanently set.

E = elastic limit of plate, about 32,000 pounds steel, 29,000 pounds iron.

t = thickness of plate.

d = center to center of stays.

a = diameter of head of stay.

Board of Trade (British) rules for flat plates:

$$P = \frac{C (T + 1)^2}{S - 6}$$

P = working pressure per square inch.

S = surface supported in square inches.

T = thickness of plates in sixteenths of an inch.

C = constant as follows:

C = 112.5 for plates not exposed to heat or flames, stays fitted with nuts only.

C = 100 for plates when exposed to heat and flame and water in contact with the plates, and stays screwed into the plates and fitted with nuts.

C = 66 for plates exposed to heat or flame with water in contact with the plates; stays screwed into the plates with riveted heads.

The working pressures for firebox plates with riveted screw stays, by this rule, would be: C = 66.

For plates.	4 in. centers of stays.	P = 237.
1/4	4 1/4	" = 198.
3/8	4 1/2	" = 169.
1/2	4 3/4	" = 323.
5/8	5	" = 269.
3/4	5 1/4	" = 231.
7/8	5 1/2	" = 196.
1	5 3/4	" = 170.

The working pressure allowed on flat surfaces by the U. S. Board of Supervising Inspectors of Steam Vessels (rules issued in 1899) is determined by the following rule:

Plates 7/16 inch thick and under, for fireboxes.

Let P = working pressure.

C = constant = 112 for 7/16 plates and under.

C = constant = 120 for plates over 7/16 in thickness.

D = center to center of stays.

T = thickness for plate in sixteenths of an inch.

Then

$$P = \frac{T^2 C}{D^2}$$

Working Pressures Allowed on Flat Surfaces in Fireboxes, Screw Stays and Riveted Heads, Calculated from Data given by the U. S. Board of Supervising Inspectors for Steam Vessels.

$$P = \frac{T^2 C}{D^2} \quad C = 112$$

Centers of stays.	Thickness of plates.				
	1/16	1/8	3/16	1/4	5/16
3 3/4	199	241	286	336	390
3 1/2	186	225	268	314	365
4	175	211	252	295	342
4 1/4	155	187	223	261	313
4 1/2	138	167	199	233	271
4 3/4	124	150	179	209	243
5	112	135	161	189	219
5 1/4	102	123	146	171	199
5 1/2	92	112	133	156	181
5 3/4	85	102	122	143	166
6	78	94	112	131	152

Provided the strain on stay or bolts does not exceed 6,000 pounds per square inch of section. On flat surfaces other than firebox, a constant of 140 is used, when the stays are screwed through and provided with nuts.

Working Pressure Allowed on Flat Surfaces other than Fireboxes, when Screw Staybolts with Nuts on the Outside and Inside of the plates are used. Calculated from data given by U. S. Board of Supervising Inspectors for Steam Vessels.

$$P = \frac{T^2 C}{D^2} \quad C = 140$$

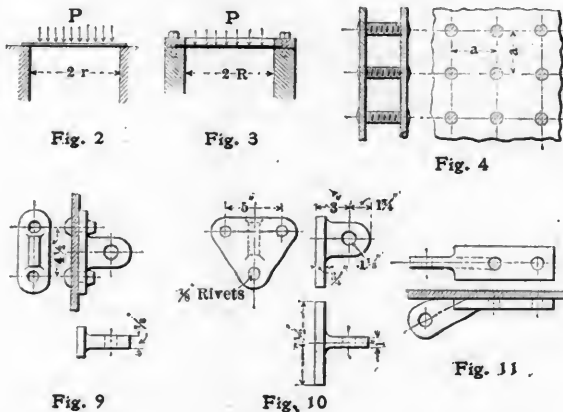
Center of Stays.	Thickness of Plates.					
	1/16"	3/16"	1/8"	1/4"	5/16"	3/8"
4	218	315	.....	.....	.....	.....
4 1/4	194	279	.....	.....	.....	.....
4 1/2	173	249	.....	.....	.....	.....
4 3/4	155	223	304	.....	.....	.....
5	140	201	274	.....	.....	.....
5 1/4	.....	.....	248	.....	.....	.....
5 1/2	.....	.....	226	296	.....	.....
5 3/4	.....	.....	.....	271	.....	.....
6	.....	.....	.....	249	315	.....
6 1/4	.....	.....	.....	230	290	.....
6 1/2	.....	.....	.....	212	268	.....
6 3/4	.....	.....	.....	196	249	307
7	.....	.....	.....	183	231	285
7 1/4	.....	.....	.....	170	215	266
7 1/2	.....	.....	.....	159	202	249
7 3/4	.....	.....	.....	149	189	233
8	.....	.....	.....	140	177	218
8 1/4	.....	.....	.....	.....	167	205
8 1/2	.....	.....	.....	.....	157	193
8 3/4	.....	.....	.....	.....	.....	182
9	.....	.....	.....	.....	.....	172
9 1/4	.....	.....	.....	.....	.....	163

Rules prescribed by the U. S. Board of Supervising Inspectors of Vessels.

Bumped Heads of Boilers.

"Pressure Allowed on Bumped Heads.—Multiply the thickness of the plate by one-sixth of the tensile strength, and divide by one-half of the radius to which head is bumped, which will give the pressure per square inch of steam allowed.

"Example.—On a bumped head 54 inches in diameter, T. S. 45,000 pounds, $\frac{3}{4}$ inch thick, bumped to a radius of 54 inches, pressure would be allowed as follows: T. S. 45,000 pounds, one sixth equals 75,000 pounds, which, multiplied by .75, the thickness, equals 5,625, which, divided by 27 inches, one-half the radius, equals 208.33 pounds pressure allowed. Where the circumferential seam in such head is double riveted to shell, which is entitled to an additional pressure there will be allowed 20 per cent. additional pressure on said head."



"The pressure on unstayed flat heads, when made of stamped material, on steam drums or shells of boilers, when flanged and made of wrought iron or steel or of cast steel, shall be determined by the following rule:

"The thickness of plate in inches multiplied by one-sixth of its tensile strength in pounds, which product divided by the area of the head in square inches, multiplied by 0.09 will give pressure per square inch allowed. The material used in the construction of flat heads when tensile strength has not been officially determined shall be deemed to have a tensile strength of 45,000 pounds."

Example: What pressure would be allowed on a flat, unstayed circular head 20 inches diameter, $\frac{1}{2}$ inch thick, tensile strength of steel plate, 55,000 pounds? Then

$$P = \frac{1/6 \ 55,000}{314 \times .09} = 163 \text{ lbs.}$$

"Pressure Allowable for Concaved Heads of Boilers.—Multiply the pressure per square inch allowable for bumped heads attached to boilers or drums convexly by the constant .6, and the product will give the pressure per square inch allowable in concaved heads."

According to Prof. Gashof the strength of flat plates is: Let t = the thickness in inches.

r = radius of circular support.

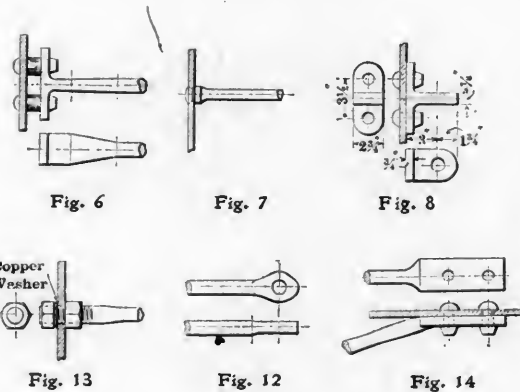
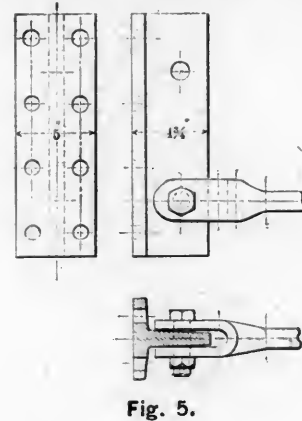
p = uniform load in pounds per square inch,

f = greatest stress per square inch.

For plates supported, but not fixed on a circular support, Fig. 2, the maximum stress is:

$$f = \frac{5r}{6t^2} P. \quad t = r \sqrt{\frac{5P}{6f}} = 0.91r \sqrt{\frac{P}{f}}$$

Example: Required, the safe distributed pressure per square inch for a steel plate $\frac{3}{4}$ inch thick supported but not fixed on a circular support 20 inches diameter, ultimate tensile strength of plate, 55,000 pounds, assuming a factor of safety of 5.5,



stress not to exceed 10,000 pounds per square inch, the working pressure will be:

$$P = 10,000 \times \frac{6}{5} \times \frac{.75^2}{10^2} = 46 \text{ pounds.}$$

For a circular plate fixed at the edges and uniformly loaded (Fig. 3) the maximum stress is:

$$f = \frac{2}{3} \frac{r}{t^2} P. \quad t = r \sqrt{\frac{2P}{3f}} = 0.81r \sqrt{\frac{P}{f}}$$

For the strength of flat stayed surfaces Prof. Unwin finds for Fig. 4,

$$f = \frac{2}{9} \frac{a^2}{t^2} P. = .222 \frac{a^2}{t^2} P.$$

When a = distance of stays center to center.

These rules are only suitable for thin flat plates strained within the elastic limit. When the plate is arched or dished, so as to form a concave or convex surface, the strength is greatly increased. Suppose $t = .3125$, $a = 4$ inches and $P = 175$

pounds, then $\frac{2}{9} \frac{4^2}{.3125^2} \times 175 = 6405$ pounds, greatest stress per square inch.

Details of different forms of braces and attachments for staying flat surfaces, are shown in Figs. 5 to 14. Where two or more braces on any one line can be used, a heavy steel T forms the best and most convenient attachment and is used in connection with braces terminating in a jaw shown in Fig. 5. Suitable ends to fasten to the boiler shell are shown in Figs. 11 and 14. Fig. 12 shows an attachment where two angle irons, back to back, are used, the brace being in the center. Two styles of throat braces are shown in Figs. 6 and 7, the former being attached to the plate with two rivets and provided with thimbles to allow free circulation of water between the plate and the brace; the latter is a round brace with enlarged end riveted hot into a deeply countersunk hole, which should be at least $\frac{1}{8}$ inch larger in diameter than the body of the brace.

Convenient forms of "crow feet" are shown in Figs. 8 and 9.

These are used for the attachment of single braces in places where tees cannot be used. Another and larger form using three rivets is shown in Fig. 10. Where long straight braces are used with nuts at each end, Fig. 13 shows the usual form of application with copper washers on the outside. The outer nut is turned cylindrical a sufficient distance to admit of using a calking tool to upset the copper washers in case it is not perfectly steam-tight when screwed up. A cap nut is sometimes used on the outside to prevent leaking around the threads, and to do away with riveting over the ends of the braces in the nuts.

CORRESPONDENCE.

BOX CAR ROOFS.

Editor American Engineer and R. R. Journal:

Noticing your article on "Box Car Roofs" in your November number, page 356, I am constrained to take issue with some of your statements, because I believe the facts developed in service do not warrant them.

It is, as you say, impracticable to build cars that will not be subject to twist and vibration under severe stresses. It is also true that "the nature of the roof framing is generally not such as to offer much resistance to bending and twisting." This is notably true of most of the modern cars. You suggest greater strength by diagonal rods in the roof or double boarding, thus admitting the desirability of increasing the rigidity of the car through the roof, and then in the next paragraph you say, "The roof certainly is not the place to stiffen the frame." This is rather a startling contradiction. Take a car well braced in sides and ends, as most modern box cars are, and it is then found desirable and necessary to stiffen the frame, where will you do it, if not in the roof? You surely can't do it by contributing "flexibility" instead of rigidity.

Now, as to a "large amount of flexibility" which you say "cars must have, and to which the roof must accommodate itself without leaking." Here, surely, is another remarkable statement. Your assertion followed to its logical conclusion would produce results in the cost of maintenance of rolling stock which would bankrupt all the Vanderbilts in the world. How would a "large amount" of flexibility do, for instance, on the "Lake Shore" or "Pennsylvania Limited," especially if that "large amount" of flexibility extended to the engines?

Now, the truth is the stiffest box car, day coach, sleeping car or engine that can be built has flexibility forced into it, so to speak, by the "service stresses" as indicated in your article, and which enforced flexibility is constantly being fortified against in old and new work.

Again, the first half of your article clearly contradicts the latter half. You quote approvingly a statement made before a Railway Club as to flexibility, and then quote approvingly from the proceedings of the M. C. B. Association as to stiffness. Which horse shall one ride?

No, if any truth relating to car construction and founded on service experience has been clearly demonstrated, it is that a roof must contribute its full share of stiffening to the frame. This fact is borne out by the most approving testimony of the most thoughtful men who have formally expressed themselves in reports of Committees or M. C. B. Associations. They have clearly and unequivocally stated that the four long sides of the box of a car should be boarded in solidly "to stiffen and strengthen it."

Now, flexibility is highly undesirable, because it contributes very largely to the cost of maintenance. Take a car with an outside metal roof, and that affords the flexibility you approve—under load—and its strain producing movements are simply astonishing to anyone who will take the time to watch it from the top of a train. There is not only a swaying, twisting motion, but it is serpentine, as well, the effect of which is manifested in the nails working out of roof boards, as well as sides of the car. Not only that, but the whole structure is loosened in tenons and braces and tie rods and inside ceilings. Now, it must be readily evident that when the top of the box of a car is also boarded over before the roof is put on, the

effect of twisting and serpentine movement is reduced to the minimum—the least obtainable on a box car at a usable cost.

Once having the body of the car as rigid as possible, i. e., solidly enclosed on four sides, but subject to enforced flexibility, it then becomes highly desirable to have a flexible roof. Perhaps that is what you really mean in your advocacy of flexibility.

There are flexible and inflexible car roofs. The flexible roof has strain adjustability—is torsion proof—because it is not fastened to the body of the car in such manner as necessarily to adjust itself to strain. Such a roof—fabric or metal—can never be unfavorably affected by torsional strain.

An inflexible car roof is one nailed at all points to the structure of the car and hence must be subject to all strains and twists affecting the car. Such roofs soon become leaky, no matter what the material. If of fabric, they tear; if metal, they crystallize, and there is only "vexation of spirit."

There are one or two additional points in your article to which I would like to refer in a deferred communication.

November 18, 1899.

B. C. ROOF.

[We do not see that we differ with our correspondent in the essentials of this question.—Editor.]

LOCOMOTIVE INSTRUCTION IN TECHNICAL SCHOOLS.

Editor American Engineer and Railroad Journal:

At present some of the technical schools are revising their courses of instruction in locomotive engineering, while others are preparing to offer such courses for the first time; hence a few words of adverse criticism of past methods, and of suggestion for future improvement, may be productive of good results.

Locomotives operate under more variable and exacting conditions than any other class of engines, and the formulae and data derived from stationary and marine practice have little application to locomotives. As an instance of this may be mentioned the fact that, while in ordinary structures subjected to tension a factor of safety of about five is usually considered sufficient, in the design of such parts as locomotive driving spring hangers, actual practice (deduced from failures) has demonstrated that, partly owing to the greatly increased load due to impact caused by the vertical motion of the driving box and the jolting or uneven movement of the engine, and partly as the result of other causes not clearly understood, it is unsafe to allow the working stress to exceed three-thirtieths of the tensile strength of even exceptionally good wrought iron.

For students desiring to fit themselves for the duties of motive power officers and locomotive designers, the ordinary course in mechanical engineering, however admirable it may be, is not of itself a sufficient preparation, but should be followed by a special course of at least one year's duration, devoted exclusively to the study of locomotives. Cars, railway shops and machinery, air-brakes, signals, etc., should be included, and the course should be designed to give a thorough insight into general principles, rather than a knowledge of special methods and the design of details, which information can only be satisfactorily obtained in actual practice, much of it being the carefully guarded private property of railway companies and locomotive building firms.

As an example of the character of problems which a superintendent of motive power or locomotive designer is called upon to solve, and the confidence with which such work is undertaken, the following incident may be mentioned.

In 1895, the Baldwin Locomotive Works suggested to the Japan Railway Company that if a specimen of the coal found on their road and considered unfit for locomotive use—it being impossible to burn it in the fireboxes then in service—were sent to them, they would build engines to burn it and guarantee their successful operation. The sample of coal was sent from Japan; forty-four locomotives were shipped in one lot to a distant foreign country, where, in the event of litigation, the builders would have no redress, and guaranteed to burn a fuel hitherto considered worthless. The locomotives gave perfect satisfaction, proving to be remarkably free steamers, even with exhaust nozzles so large that the engines are almost noiseless in their operation.

Now, how was this satisfactory result attained? Briefly, by adopting a special, though well-known, type of firebox—

the modified Wooten—and so proportioning the grate area that a sufficient quantity of coal (whose peculiarities and calorific value had been ascertained) could be burned per hour to generate steam enough for the tractive power desired, or the traction due to the boiler pressure, and the size of the cylinder and driving wheels. This being accomplished, the design of the different parts or organs of the locomotive, so that they would function properly, not break down or require frequent repairs, did not differ from ordinary cases and presented no unusual difficulties. The broad fundamental problem being the design of an engine which would make sufficient steam to haul trains of known weight over a given road with fuel considered unfit for use.

Another and very different case was recently worked out on one of the well-known American roads. The Lake Shore & Michigan Southern Railway has passenger locomotives which will handle maximum loads of about twelve cars on schedules slightly exceeding forty miles per hour. The traffic conditions have lately become such that the Superintendent of Motive Power was called upon to design locomotives which, without exceeding the limitations of weight and space imposed by the permanent way and clearances of the road, would haul fourteen cars at sixty miles per hour, with a margin of reserve power for emergencies; to meet which requirements a single expansion, 10-wheel express engine was produced, having 80-inch drivers, 20 x 28 inch cylinders, and a total heating surface of 2,917 square feet, equal to that of the largest consolidation freight locomotive (Class H-6) of the Pennsylvania Railroad. Here, as in all cases of locomotive design, the questions were, first, What is wanted? and second, How can it be obtained?

A satisfactory course of instruction in locomotive engineering should be such as to place its graduates, after proper practical experience, in the most favorable position for satisfactorily answering such questions, to accomplish which purpose special prominence should be given to the elucidation of the fundamental principles underlying the design of efficient locomotives; to the explanation of the requirements of modern engines, and how they are met under existing limitations: the tendencies of recent practice, and the probable characteristics of the locomotive of the future.

These are the most important subjects for the technical schools to teach, for, unless so taught, they can only be acquired by years of practical experience and observation, and it is precisely in neglecting to give proper instruction in these underlying principles, and by making the design of details the essential feature, that many of the college courses in locomotive engineering have hitherto been radically defective.

On the other hand, while the consideration of the design of details should not be given undue prominence, it must be remembered that the managements of the leading railroad companies now accept no excuse for engine failures, and consequently the study of successful practice as exemplified in designs which do not break is extremely important, and this involves questions of the resistance of materials under specially difficult and frequently misunderstood conditions.

One of the most admirable features of medical education is the systematic instruction given by eminent physicians and surgeons in regular practice, and, while it is probably impracticable to follow a similar course in engineering education, it is evident that, unless the technical schools are willing to offer such salaries as will induce able motive power officers and locomotive designers to vacate their positions and become teachers, the best results, for the students, at least, cannot be obtained; the tendency being for the course to become either an extravagant exercise in applied mathematics, or to degenerate into a mere catalogue of obsolete locomotive details.

EDWARD L. COSTER,

New York, Nov. 20, 1899.

Assoc. M. Am. Soc. M. E.

[Comments upon this subject will be found on page 391, this issue.—Editor.]

A tie growing experiment is reported to be under consideration by the "Big Four," between Brightwood and Ingalls, in Indiana, on land owned by the road. It is estimated that catalpa trees, imported from Kansas, planted now, will attain a height of 60 feet and a diameter of 20 inches in about 16 years.

RAIL WASHER TESTS.

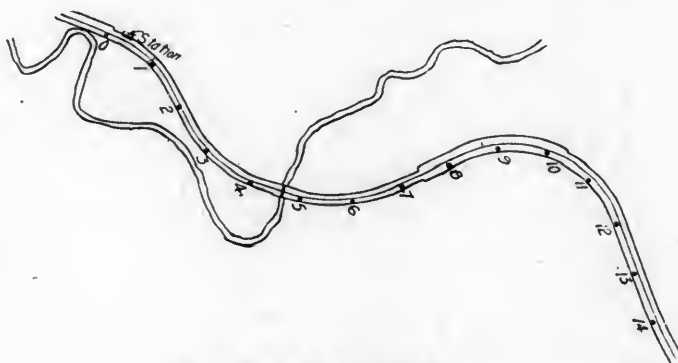
Chicago, Burlington & Quincy R. R.

Train Resistance Due to Rail Sanding.

Dynamometer Tests.

The effect of sand placed upon the rail to increase the adhesion of locomotive driving wheels has been known to be important in increasing the resistance of trains and the subject has, we believe, been submitted to a careful test for the first time by the C., B. & Q. Railroad, and the American Engineer and Railroad Journal has been favored with the results of careful dynamometer experiments conducted by the motive power department of the road under the direct supervision of Mr. J. A. Carney, Master Mechanic of the St. Louis Division, and Mr. M. H. Wickhorst, Engineer of Tests.

This work resulted from discussions with train and engine men with regard to the use of the rail washer, the men claiming that it would make a decided difference in the ease with which heavy trains may be pulled over grades, and especially those involving curvature. Preliminary experiments were made in the Galesburg yard to determine the effect of the rail washer, and it was found that its advantage was so slight upon a heavily sanded rail and a straight, approximately level track that it did not at that time appear to warrant the introduction of the device on main line engines. The claim was

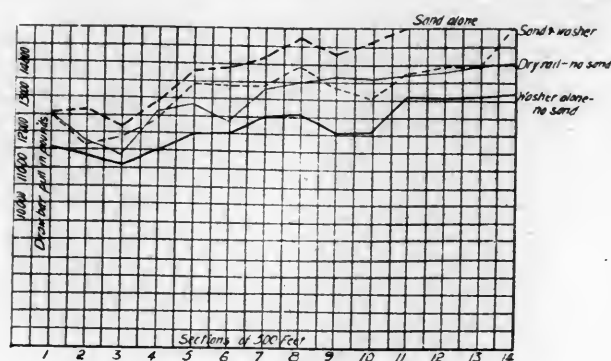


Curves on Arenzville Hill.

made by men on the St. Louis Division that by wetting the rail lubrication is provided to a certain extent, reducing the flange friction on curves. The almost unanimous opinion resulted in dynamometer tests to settle the question.

The object of the tests was to determine the difference in train resistance when sand was left on the rails after the passage of the engine, and where the sand was washed off behind the drivers with a rail washer, which consists of a pipe tapped into the boiler below the water level, with a branch extending to each rail so that the sand may be washed off by a stream of hot water and steam under the control of suitable valves. The dynamometer car, which is a part of the equipment of this road, was used and the trials were made on October 31 on Arenzville Hill, on the St. Louis Division, where the desired track conditions were found. The hill was staked out in 14 sections, each 500 feet long. One of the engravings is reproduced from a map showing the line of road and the curves on this hill. The grade throughout the space covered is 1.3 per cent. and uniform; the location of the stakes is shown in the engraving.

The weather was fine, and there was very little wind. The full train consisted of 12 loaded cars, with a dynamometer and caboose; other tests were made with three-fourths of a full train, consisting of nine loaded cars, the dynamometer and caboose. The following record shows the order of the tests and indicates that in three cases, with a full train of 3,967 tons, and where sand was used without the washer, the train



Full Train Record.

stalled before reaching the top of the hill, at sections 10, 11 and 12. In all the other cases the train was pulled up over the course without stopping.

Record of Tests.

Test No.	Time.	Condition of Rail.	Train.	Remarks.
1	7:55 A. M.	Sand alone.	Full train.	Preliminary test.
2	8:33 A. M.	" "	(3,967 tons.	Stalled on Section 10.
3	8:46 A. M.	Sand and washer	" "	" "
4	9:16 A. M.	Sand alone	" "	Stalled on Section 12.
5	9:30 A. M.	Sand and washer.	" "	" "
6	11:15 A. M.	Sand alone.	" "	Stalled on Section 11.
7	11:38 A. M.	Sand and washer.	" "	" "
8	11:52 A. M.	Dry rail—no sand.	" "	" "
9	12:16 P. M.	" "	" "	" "
10	2:15 P. M.	Washer alone—no sand	" "	" "
11	2:30 P. M.	" "	" "	" "
12	2:49 P. M.	" " " "	(3,028 tons.	" "
13	3:40 P. M.	Sand alone.	" "	" "
14	3:52 P. M.	Washer alone—no sand	" "	" "
15	4:03 P. M.	Sand alone.	" "	" "

The complete report includes the average drawbar pull for each section of 500 feet for each individual test, together with the number of seconds required to pass over each section. It also shows the average drawbar pull for the 14 sections when the engine succeeded in getting up the hill. It gives the average drawbar pull for the tests over the first nine sections with a full train. The summary of the results is given in the following table:

Summary of Results.

Summary—Full Train.

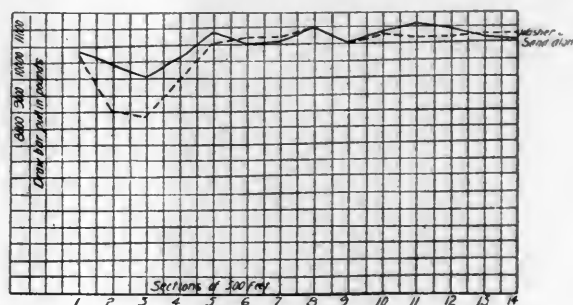
Condition of Rail.	No. of Sections.	No. of Av. D.-B. Pull.	Rating.	Rating.
Sand alone.....	9	13,436	100 %	107.5%
Sand and washer.....	9	12,868	95.7%	102.9%
Dry rail.....	9	12,511	94.8%	100 %
Washer alone.....	9	11,830	88 %	94.7%

Summary—Three-Fourths Train.

Sand alone.....	14	10,585	100 %
Washer alone.....	14	10,275	97 %

It will be noticed from this summary as to the full train tests, taking the dry rail as normal and rating it at 100 per cent., that when sand was left on the track the resistance was increased by 7.5 per cent.; when sand was applied and then washed off with a washer the increase of resistance was 2.9 per cent, and when the sand was not applied, but the rail was wet by the washer the resistance was decreased to 94.7 per cent. In the tests with the three-quarters load the difference is decidedly less. In this case, calling the resistance where sand was applied 100 per cent., the resistance where no sand was applied but the rail wet with the washer decreased to 97 per cent., a difference of only 3 per cent. in this case.

These results are shown graphically for ease of comparison, the averages having been plotted in the two diagrams which we reproduce. No tests were made with application of sand and afterward the washer to wash off the sand in the case of the lighter train, because it was assumed that the results would be the same as in the application of the washer to the dry rail. The diagram of the full train shows that the resistance is materially greater when sand is applied and then washed off than when the washer alone is applied. It should be stated that the drawbar pulls are reported as they were taken



Light Train Record.

in the tests without correcting for the differences in internal train friction resistance due to differences in speed and for differences in train inertia resistance due to differences in the speed retardation, because the amounts of correction would not be very different in the different cases. If these corrections were applied the draw-bar pulls would be increased slightly, and a little more when sand alone was applied in the case of the full train tests, since the speed retardation was greater in these cases. In the case of the light trains no corrections were necessary, since the variations in speed were very slight for the different tests and for the different sections in each test. If these excellent results were obtained at an excessive cost, due to the amount of water used by the rail washer, the practical value of the device would be very small, but tests conducted by Mr. Carney showed that the amount of water consumed with the throttle valve to the washer pipes fully open was 36 pounds of water per minute as a maximum. His opinion is that the average amount of water used per minute is about 20 pounds, which would be equivalent to a little over 1 pound of coal per minute. If the rail washer is applied for 6 minutes in getting up the hill it would mean the consumption of about 7 pounds of coal and 140 pounds of water, which is very little cost when considered from the standpoint of the advantage in the possibility of hauling additional loads and insuring against the stalling of trains.

Summing up, it may be stated that these tests show a material reduction in train resistance due to washing the sand off the track under the conditions of grade combined with difficult curvature, such as exist on this hill. In a train of 20 loaded cars this is equivalent to the hauling of one extra car. The results also indicate that where the rail is good and no sand is needed, that it is an advantage to apply the washer alone. When a train passes a curve, one wheel of each pair must slip; that is, half the wheels in the train must slip upon the rails. This probably accounts for the good effect of having the sand washed off the rail, and of wetting the rail.

In such work as this a railroad may secure information by the use of a dynamometer car, which will render such an addition to its equipment a most satisfactory investment. The whole idea of the tests and the practical value of the results obtained on this occasion and in many other similar investigations on this road should bring the dynamometer car before progressive railroad men as a very important factor in reducing operating expenses. In this series of tests, which were concluded in a single day, information was obtained which will mean one more car per train over the St. Louis Division for future years. This result alone will pay, over and over again, the total expense of this car ever since the Burlington Brake Tests and including its first cost and replacements. The wonder is that every strong road does not see the real value of the dynamometer car and of the kind of men who can use it to such effect.

A type of compound locomotive in use on the Chemins de Fer du Nord, of France, described in "The Engineer," has high-pressure cylinders 13½ inches, and low-pressure cylinders 20½ inches in diameter by 25 3/16 inches stroke. The initial steam pressure is 213.3 pounds per square inch, the diameter of driving wheels is 84 inches, the grate area is 24½ square feet, and the heating surface 1,890 square feet.

STAYBOLT PROGRESS.

The test of time is the most reliable and altogether satisfactory one for the study of the staybolt problem in locomotive practice, and the vibration tests which now attract the attention of the leaders in the pursuit of this subject have developed several facts of great importance because they are really time tests. It is not the tensile strength but that property of the metal which enables it to bear repeated bendings which determines the life of a staybolt. If a perfectly flexible material of sufficient strength was available the solution of the difficulty of the breakage of staybolts would be had, but in the absence of such material it is necessary to use the best to be found and then to surround it with the most favorable condi-

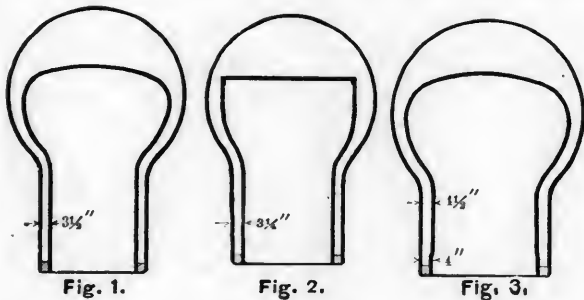


Fig. 1.

Fig. 2.

Fig. 3.

tions. Progress has been made toward improvement since the summary of staybolt practice was printed in our issue of September 8, 1897, page 319, but it is believed that the increase of steam pressures is moving faster than that of the improvement in staybolts. This is why it is important to review the subject.

Remarkable Staybolt Material.

The recent cutting up of an old locomotive boiler after it had been in active service for nearly 20 years presented some interesting questions. This boiler was equipped with staybolts $\frac{7}{8}$ inch in diameter, which were turned down to a diameter of $\frac{5}{8}$ inch in the center, with a long fillet at each end. The original firebox sheets and a large part of the original staybolts were still in use, although of course a number had been renewed. The points of interest in this case are: First, That so many of the staybolts should have lasted for nearly 20

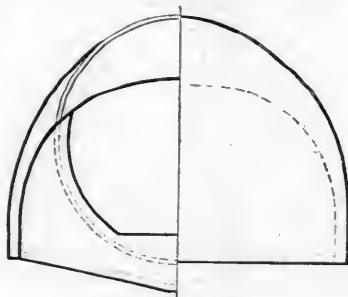


Fig. 4.

years; second, that the firebox should have lasted so long a time and yet be fit for further service, and, third, that some of the staybolts should have broken near the firebox side, instead of near the outside shell. A case of a staybolt breaking at or near the firebox side is almost unheard of and it would seem that if the form and method of attachment are found which will cause the bolts to break at either sheet all has been done that is possible with that size of staybolt. Examination of this staybolt iron by etching and by tests showed it to be remarkable material. Its tensile strength was from 55,000 to 58,000 pounds, and the elongation was 40 per cent. in 2 inches. This was not steel, as might be supposed from the high tensile strength. It was box piled, faggotted iron made up, as shown by the etching, of very small squares

covered by a box on the outside. The iron seemed to be very highly refined before being rolled into the small bars of square section. This is shown very clearly in the fractures. The structure of the iron appeared to be like that of a rope with square and untwisted strands. Little if any iron is to be found at the present time with tensile strength and elongation as high as this, although the best special staybolt irons often run up to 53,000 pounds tensile strength and 30 per cent. elongation in 8 inches. Of course the boiler pressure has a

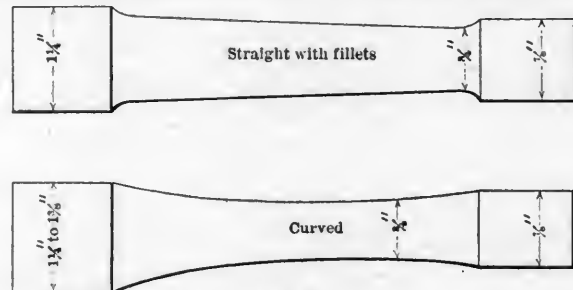


Fig. 5.

great deal to do with the life of staybolts. In this particular boiler it was 125 pounds during the more recent years and possibly 140 pounds during its earlier days.

Form of the Firebox.

If staybolts could be made of sufficient length to permit of the maximum movements of the firebox due to expansion and contraction without bending them beyond the elastic limit of the material and without reaching the point of permanent set the dangers of breakage would be greatly reduced. It is out of the question to materially increase the length of the bolts which give the most trouble in narrow fireboxes, but with wide fireboxes there seems to be no reason why moderately long bolts may not be used without any important disadvantage. With fireboxes of the narrow type (between the driving wheels) the shape may be much more favorable than is often the case. On page 179 of the June, 1899, issue of this journal

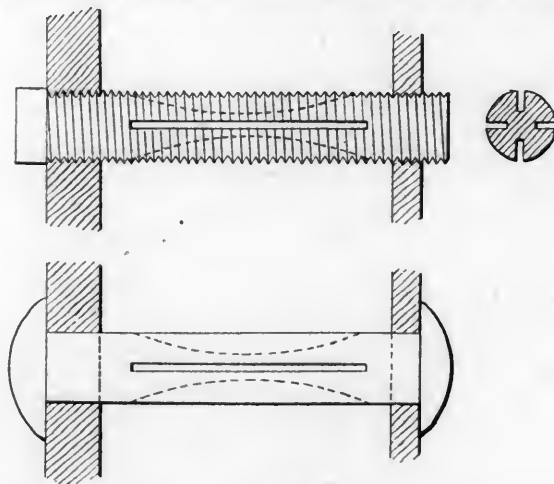


Fig. 6.

a boiler is illustrated in which the water spaces, while 4 inches wide at the bottom, increase both at the sides and back end in order to give as great length as possible.

The shape of the firebox sides may be varied quite a little with a marked effect on the staybolt breakages and probably much more influence than is generally appreciated. Of the three forms of fireboxes shown in Figs. 1, 2 and 3, the first represents 10, the second 18 and the third 24 locomotives, which were compared for staybolt breakages during a period of six months and gave the following results:

Fig. 1.—226 broken.

Fig. 2.—124 broken.

Fig. 3.—32 broken.

Standard Forms of Staybolts.
C., B. & Q. R. R.

Diameter.		Radius of Curves in Inches	Length Between Sheets.																
Nominal.	Actual at Center.		3 in.	3¼ in.	3½ in.	3¾ in.	4 in.	4¼ in.	4½ in.	4¾ in.	5 in.	5¼ in.	5½ in.	5¾ in.	6 in.	6¼ in.	6½ in.	6¾ in.	7 in.
¾ in.	1 in.		42	42	42	42	42	80	80	80	80	80	80	140	140	140	140	140	140
1 in.	1 1/16 in.		23	23	23	23	23	42	42	42	42	42	42	80	80	80	80	80	80
1 1/8 in.	1 1/4 in.		23	23	23	23	23	42	42	42	42	42	42	80	80	80	80	80	80
1 1/4 in.	1 3/8 in.	23	23	23	23	23	42	42	42	42	42	42	80	80	80	80	80	80	
1 1/2 in.	1 5/8 in.	23	23	23	23	23	42	42	42	42	42	42	80	80	80	80	80	80	
1 3/4 in.	1 7/8 in.	23	23	23	23	23	42	42	42	42	42	42	80	80	80	80	80	80	

The first is a radial stay boiler with a deep firebox and 3 1/2-inch water spaces, carrying 180 pounds of steam; the second is a crown bar boiler with 3 1/4-inch spaces, carrying 150 pounds, and the third is a radial stay boiler with a rather deep firebox but 4 1/2-inch water spaces and less abrupt curves at the sides. This is an easy matter to provide for in designing, and the reason for the good results is very clear.

A shallow firebox is much more favorable to staybolts than a deep one, and with wide grates, over the wheels, the best possible arrangement for the staybolts seems to be available, viz., a shallow box, an even and uniform curvature of the sheets and long staybolts. The curvature of the sheets is believed to be important. It has been found advisable in the construction of very wide fireboxes to give the sheets a uniform curvature from one side to the other, not that the section of the firebox is an arc of a circle, but the outline is free from angles and straight lines which tend to localize the movements and stresses due to expansion and contraction. In 10

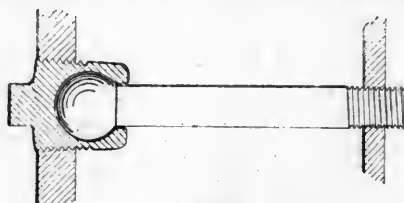


Fig. 7.

engines with fireboxes of the form shown in Fig. 4, but 3 broken staybolts were found in a period of 13 months. This is believed to be due to the shape of the sheets, and the length of the staybolts which begins to increase immediately above the lower rows, and the stays are very nearly radial throughout the firebox. The record is a very encouraging one, which appears to add an argument to those in favor of wider fireboxes. Fig. 4 may fairly be said to represent the forms of the Lehigh Valley Baldwin Compounds (page 11, January, 1899), the Long Island and Consolidations by the Brooks Works (page 92, March, 1899), and the most recent Brooks 12-wheel engines for the D., L. & W. Ry. (page 365, November, 1899). These engines are all reported to be giving good results and this shape seems to be likely to last.

Forms of Staybolts.

For a number of years the practice of reducing the size of the central portions of the bolts between the threaded ends has been rather common. Two recent investigators believe that the idea is theoretically good, but that it does not show marked results in vibration tests. The long service of the staybolts referred to in the first part of this discussion seems to prove the value of the flexibility obtained in this way. Efforts have been made to design such a form as would insure against the breakage occurring always at the outer sheet. Fig. 5 shows the results reached by two prominent locomotive authorities who worked out their ideas independently and both sought the theoretically correct form. They differ in nothing except the form of the section between the fillets. The difficulty with this plan is to make and insert the bolts. This can be done, but at increased expense, because of the two sizes of holes to be drilled and tapped for each staybolt. The form shown in Fig. 6 was designed by Messrs. Stone &

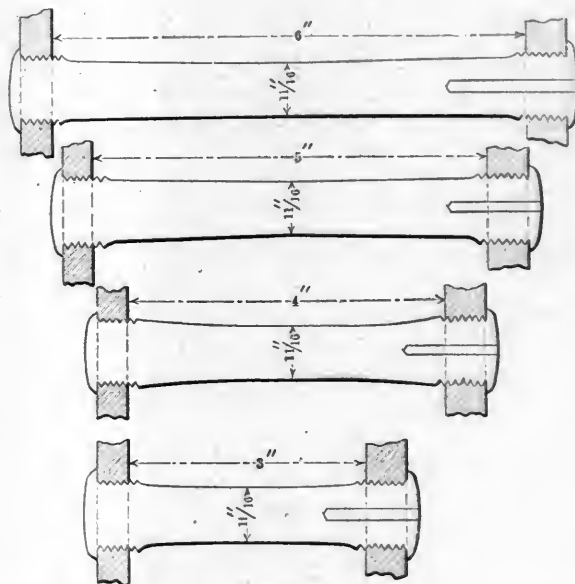


Fig. 8.

Co., Deptford, England, for the purpose of giving flexibility. The staybolt is apparently cut in two planes by a circular saw with a thin blade. Mr. William F. Pettigrew in his new book says: "It is represented that these stays will stand 30 times as many strains as the ordinary stay, and where they have been tried they have given very good results." The experience with this form has probably been confined to England, but experimenting with them on a large firebox in this country would be worth while. They are used in steel fireboxes on the Great Eastern Ry. of England.

A really flexible staybolt is sure to be durable. The form shown in Fig. 7 has been suggested as a means for providing flexibility at the outer sheet, but it is not known to have been tried in service. Doubtless this idea may be worked out successfully, and perhaps without making the work too expensive. This is believed to have originated with Mr. F. W. Johnstone, Superintendent of Motive Power of the Mexican Central.

Fig. 8 illustrates the form of the standard staybolts of the C., B. & Q. R. R., which gave excellent results in a recent series of vibration tests. These bolts with drilled holes withstood more vibrations than any others, except nickel steel, in a comparative test of six different forms and materials. On new work, on the Burlington, 7/8-inch bolts are used, the lengths varying by 1/4 inch, and the shape being as given in the table. In renewing staybolts, sizes up to 1 3/16 inches are used as the work requires, and if larger ones are needed the holes are bushed and standard sizes are put in. The minimum diameter of 7/8, 5/16, and 1-inch staybolts is 11/16 inch, and for bolts over 1 inch diameter the minimum diameter increases 1/32 inch for each 1/16 inch increase in the nominal diameter.

The Riveting of Staybolts.

The form and size of the riveted head of the staybolt is known to greatly influence the life, and that the riveting is very important is proven by the wide variations in the results of tests in vibration machines with bolts secured in this way. At least three different experimenters have tried unsuccessful-

fully to carry out tests in which the bolts were riveted into sheets, but the results were so variable as to be valueless. The heads loosened first, and the bolts finally broke near the edge of the plate. It has been stated that bolts driven according to the method suggested by the United States Government gave materially improved results. The amount left to be headed over on a one-inch bolt was $7/16$ inch; after upsetting the end by a few sharp blows the bolt was driven by a bottom set and when driven by this method it withstood more bendings than those with low conical heads and also bolts remained tight longer. The explanation is that this method of driving made the bolt stiffer at the sheet and threw a part of the flexure into the portion between the sheets. An experimenter whose opinion is held in high esteem, says: "There is no question but that the heading over the plate has more influence on the strength of the staybolt than any other one factor. It has been found that the United States Government specifications for heading staybolts gave a much more uniform test, as well as showing much longer life. The Government requires the heads to be made with a set and use no hand work on them."

There are two ways in which to look at this question of driving. Loose bolts do not break, and it seems highly probable that very tight bolts with provisions for bending will have increased life; it is better to have them tight.

Detector Holes in Staybolts.

When the detector holes were first used they were drilled after the completion of the boiler and many still keep up this practice. For the sake of economy it afterward became customary to punch the holes in the bolts in the shop. Methods of punching and etching prints of punched bolts were shown in the *American Engineer*, April, 1898, page 121. It has developed that in spite of opinions to the contrary, drilling is better than punching and in a number of shops the holes are now drilled before the bolts are threaded. It has been shown by vibration tests that the holes, whether punched or drilled, increase the life of the bolts, but that drilling is the more effective. The punching seems to cause the breakage to occur in a ragged, irregular way, which would indicate that the deformation of the material was not advantageous. In one series of tests the number of vibrations with the holes drilled was nearly $2\frac{1}{2}$ times as great as in the case of the same form with punched holes.

Thin Sheets.

There is a tendency toward the use of thinner firebox sheets in spite of the increase of boiler pressures, the purpose being to reduce the rigidity of the firebox structure and to relieve the staybolts by inducing some flexure in the sheets themselves. Examples are seen in the new Lake Shore passenger engines with inside firebox sheets $\frac{3}{8}$ inch thick; the large 12-wheel freight locomotive for the Illinois Central with inside sheets $7/16$ inch thick and the Class H 6 consolidation engines of the Pennsylvania, in which the inside sheets are only $5/16$ inch, and the outside sheets but $\frac{3}{8}$ inch thick.

The Pennsylvania practice is believed to be a satisfactory indication that much thinner sheets are to be used than were formerly considered necessary. Outside firebox sheets less than $\frac{1}{2}$ inch thick appear radical, but because of the support given by the staybolts more than this is probably not necessary. It is reasonable to expect the stays to be more reliable in supporting the sheets if the latter are thin and flexible.

Staybolt Material.

The influence of the quality of the material is important, as was shown by Mr. F. J. Cole before the American Society of Mechanical Engineers last year. The material should not only be good, but should be uniformly able to withstand the stresses and the test of quality is in the vibration machine. As already mentioned, some of the irons available about 20 years ago are worthy of attention in this respect and more will be said in this connection. The very best iron should be obtained regardless of cost.

Nickel steel seems to be able to withstand alternating

stresses very well, and better than any other material, yet it appears to be barred out from practical consideration because of the difficulties of working. It is necessary to thread the bolts in a lathe or to anneal them before cutting the threads in a bolt machine. Good iron is undoubtedly the best material.

Piling Structure of Staybolt Iron.

The most intelligently prepared specification for locomotive staybolt material in this country contains the following

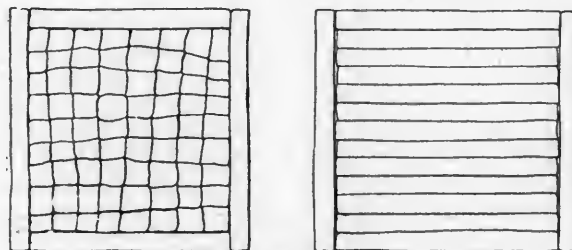


Fig. 9.

clause: "The material desired is fagotted iron, free from admixture of steel and preferably box-piled, the filling being of rods."

Fig. 9 indicates two methods of piling iron for staybolts; the first is intended to represent what is referred to as "box piling," and the other is slab piling. It is clear that in the first the structure is such as to enable one portion to support the others in whatever direction the bending occurs, whereas in the second there is a marked difference in the support in the different planes of bending. The numbers of vibrations representing the first and second structures are recorded as



Fig. 10.

from 5 to 1 and 2 to 1 in favor of the first in tests made by two careful experts working independently and on different irons. If the slab piled iron is bent with the piling in the vibration machine it gives good results, but when bent against the piling it is less satisfactory, even if the material is equally good. No satisfactory etching print of a box piled piece showing the rods is available, but Fig. 10 shows the structure, within the box, although this specimen is not a staybolt. It is an axle of a kind not seen nowadays and is made of 81 distinct pieces welded together in working.

Fig. 11 shows etched ends of five different well-known brands of staybolt iron, Nos. 1 and 3 of which exhibit the slab struc-

ture, while the others are more irregular. The irregular piling seems to a certain extent to act like the box piling in furnishing the internal support which is so desirable in resisting repeated bendings. An excellent example of the slab piling is seen in Figure 12. There is good reason to believe that irons represented by Fig. 12 should be tested in a lathe with a weight upon the unsupported end, in order to insure against misleading conditions. (This is a section of an axle.)

An excellent example of carefully worked iron which shows the irregular structure, apparently so desirable, is presented in

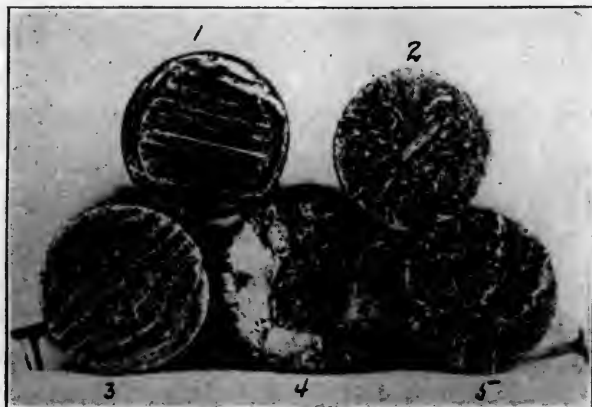


Fig. 11.

Fig. 13. This engraving is from an etching of a piece cut from a bar taken at random from storehouse stock. It is superior iron and the etching in this case confirms its good reputation.

The internal structure of another special staybolt iron is shown in Fig. 14; this, like Fig. 13, is engraved in wood from the original etching prepared from a commercial sample of



Fig. 12.

the material obtained from railroad storehouse stock. Fig. 14 shows a very different structure from Fig. 13. The material has some hard spots, but aside from these its iron is so homogeneous as to render it difficult to secure a good etching for engraving. This iron appears to be pilled finally in slabs, each slab being comprised of rods. Its structure differs from Fig. 10 in the way it is made, but it also differs from Fig. 12, and from Sections 1 and 3 of Fig. 11. The structure of Fig. 14 re-

sembles, in general principles, the box pilled iron but it is not strictly an example of that structure.

Fitting.

The application of staybolts so as to insure uniform duty on each and freedom from initial stresses is difficult and the subject is sufficiently important for more thorough treatment than can be given here. The accuracy of the threads is now being carefully measured, and this cannot fail to produce improvements. Mr. H. A. Gillis, of the Richmond Locomotive Works, stated before the Master Mechanics' Association last summer that he had ordered staybolt taps in the open market from every known maker of any reputation whatever, and "found only two taps out of the number that were anything like right." This situation is bound to improve when the necessities are appreciated. The ideal to be sought for is a uniform condition of initial stress among the staybolts. This cannot be secured under prevalent practices in which the inside sheet is deflected as much as $\frac{3}{8}$ inch by the pressure of the reamer on the end of the staybolt tap which is fed into the hole with a $\frac{1}{12}$ inch feed per revolution. This is true of the usual method of reaming the inner hole by a reamer on the end of the tap while the hole in the outer sheet is being tapped by another portion of the same tool, and unless precautions are taken to bolt or clamp the sheets together while the reaming is going on, the inner sheet is sure to be pushed away. The shape of the thread is also important. There is no reason why a staybolt thread should fit the sheet at the bottom. There should be a small space between the top of the thread in the sheet and the bottom of the thread on the bolt. The United States standard thread is better than a sharp V thread for the bolts because the sharpness of the threads at the bot-



Fig. 13.



Fig. 14.

tom is equivalent to nicking the bolt and is an invitation to fracture.

Vibration Tests.

These tests seem to have thrown a great deal of light on the staybolt problem, chiefly, no doubt, because they indicate in a large measure what may be expected from long time service tests, and they may be made to very nearly reproduce practical conditions. These tests are now required in the examination of staybolt material in the specifications which are mentioned below and they are considered as giving important information in regard to the material. The effect of the internal structure of the material, however, is such as to raise the question whether these tests should not be made in a revolving instead of a reciprocating machine. The revolving method, with a weight hung on the free end of the specimen, bends the bolt in all directions, whereas in a vibrating machine the motion may happen to be in the most favorable or the most unfavorable directions. It has been very clearly shown that rigid clamping of the fixed end of the specimen (in the vibrating machine) is necessary to uniformity of results and for this reason the riveting of the specimens into pieces of plate for testing purposes has been discarded. Specifications which have been found to secure satisfactory results, include the following: Tensile strength, not less than 48,000 pounds per square inch; elongation, not less than 25 per cent. in 8 inches. Specimens when threaded with sharp "V" threads shall be firmly screwed through two holders $\frac{5}{8}$ inch thick and with a clear space of 5 inches between them. One of these holders shall be rigidly secured to the bed of a suitable machine, and the holder at the other end shall be vibrated alter-

nately $\frac{1}{8}$ inch on each side of the center line. When thus tested, acceptable iron should show not less than 2,200 double vibrations before breakage. If either of two bars stands less than 1,700 double vibrations or the two give an average of less than 1,900 double vibrations before breakage, the material is rejected.

Conclusions.

The most promising improvements in staybolt practice are: Favorable outlines in the firebox sides, giving smooth curves and allowing the maximum length for the staybolts; such forms of the bolts as will cause the flexure to be distributed over the portion between the sheets; the drilling of tell-tale holes; thin and yielding firebox sheets; the best quality of material; such a structure of the staybolt material as will permit one portion to support its neighboring portions, no matter what the direction of bending; accurate fitting of the threads and accurate pitch of the bolt and tap threads and a correspondence of the pitch in both sheets. It is too early to state positively the effect of the recent experiment on corrugated fireboxes on the New York Central, but success in this direction looks very promising. It may be said that the Vanderbilt boiler on this road has been satisfactory thus far. No serious difficulties have arisen and there seems to be good reason to believe that the experiment will prove it to be possible to do without staybolts altogether in locomotives on American railroads. The fact that five engines now building for this road are to have these fireboxes is interesting.

PISTON VALVES.

With Two Bar Front Frames.

Norfolk & Western Railway.

The Norfolk & Western Ry. has given a great deal of attention to piston valves for locomotives. On page 38 of our issue of February, 1898, an account of an application of valves of this type was given describing their arrangement in a locomotive that was formerly a compound. The latest development is shown in the accompanying engravings, illustrating their use in an engine with two bar front frames combined with a location which places the valves in the direct path of steam in entering and leaving the cylinders. These valves take steam at the center and exhaust it at the ends. The advantages claimed for this are, first, the protection of the entering steam from radiation on account of the jacketing by the exhaust, and, second, the absence of high steam pressure upon the valve stem. In the plan followed in this case the valve motion is connected with the valve in a very direct way without using bent eccentric rods or crooked connections.

Before adopting this arrangement of the valve motion another, which was much more complicated, was tried. This made use of a system of horizontal levers, connecting the link block with the valve stem, but while giving a good valve motion the use of the plan was not extended because of the large number of joints. The form illustrated has been applied to four locomotives recently rebuilt and is giving good results. The valves are made in two parts in order to get them in between the bent portions of the front frame sections. The valves have three narrow packing wings, like those previously illustrated. These valves are provided with peep holes through the castings to permit of watching their edges while they are being set.

The arrangement of the valve motion is illustrated in plan and elevation. A short substantial bar connects the link to the end of the valve rod. It is hung on two links of equal length, giving a parallel motion which does not introduce any irregularities into the action of the valve. The valve stem is guided at the back end and moves in a straight line, the valve rod being connected to it by a pin joint. A valve motion could hardly be more direct than this unless the valve stem and link block could be placed on a level which would avoid the neces-

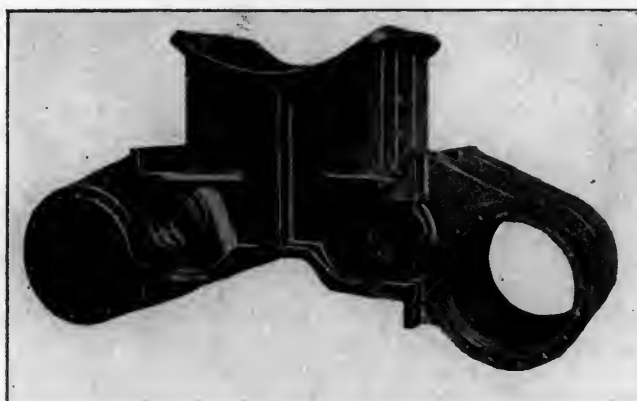
sity for the parallel motion. Such a location, however, would not give a favorable arrangement of the steam passages in the saddle casting, even if it could be accomplished.

Piston valves need special protection from water of condensation, from the resistance of the pistons and from the cutting action caused by drawing cinders and dirt from the smokebox while drifting, and for these purposes a novel relief valve has been used, designed, and, we believe, patented by Mr. G. R. Henderson, formerly Mechanical Engineer of this road, and now Assistant Superintendent of Motive Power of the Chicago & Northwestern. This valve is shown in the cylinder drawing. It opens a passage connecting the steam port from the cylinder with the steam passage in the saddle so that when drifting with steam shut off a by-pass from one end of the cylinder to the other is provided to prevent sucking air into



Showing End of Valve Casing Between the Frames.

the cylinder through the exhaust pipe. Unlike the usual relief valve, this opens by gravity and does not require a vacuum to be formed in order to bring it into action. Upon opening the throttle the steam pressure under the valve closes it against its seat and it remains closed unless by reason of the presence of water in the cylinder the pressure above the valve exceeds that of the steam pressure from the boiler. In that case the valve relieves the cylinder. Another advantage of this valve lies in the fact that it opens when the engine stops, and there is no danger of the engine being moved unintentionally in

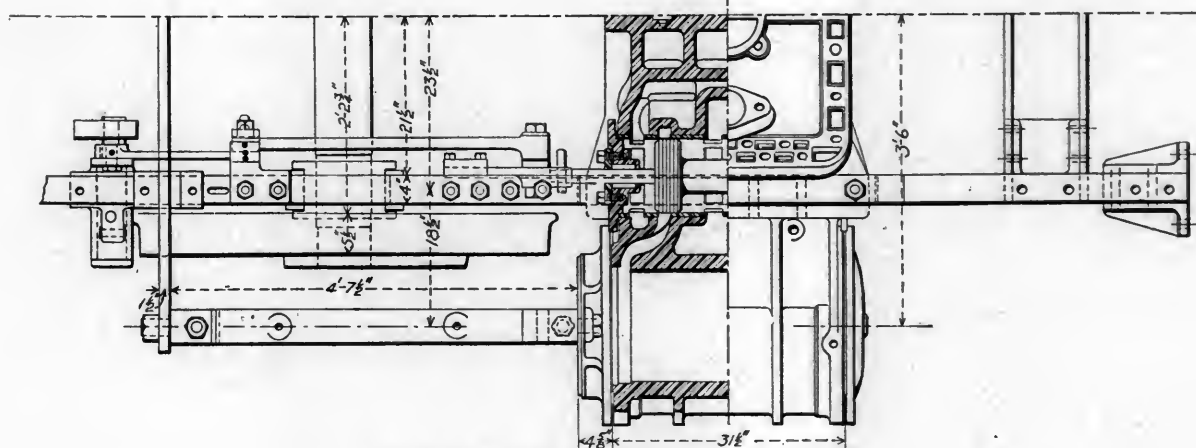
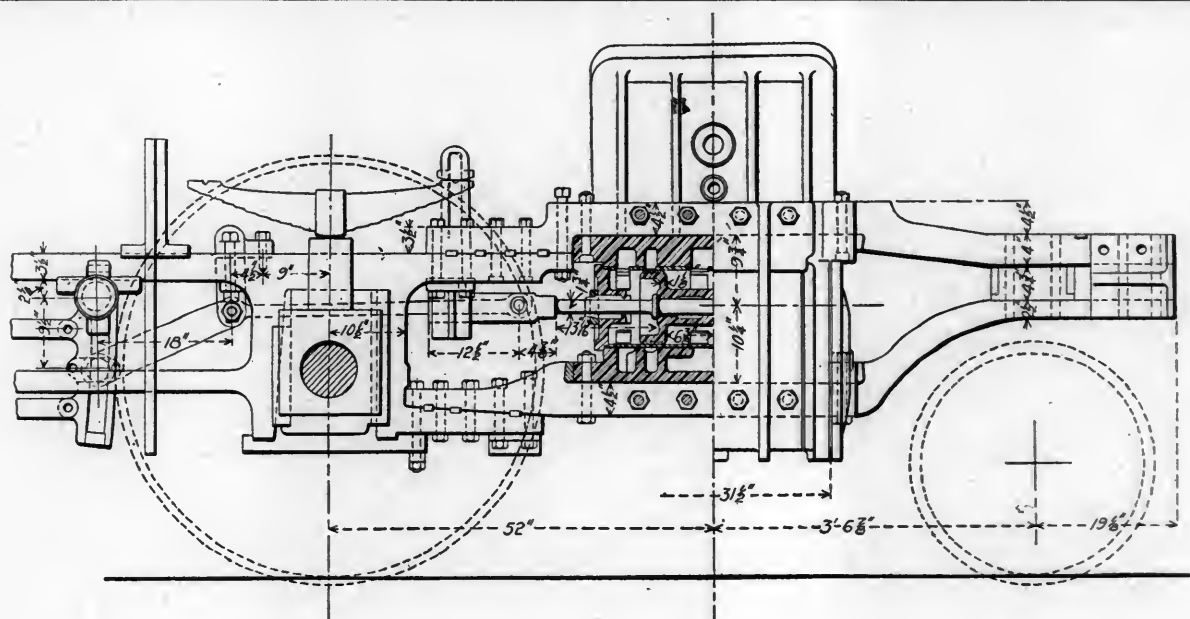


Cylinders and Saddles.

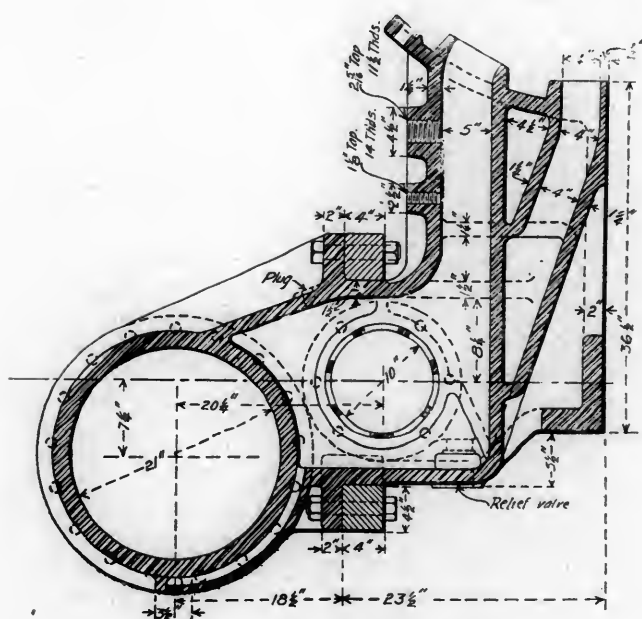
case the throttle leaks. The drawing shows the construction of the valve and seat and the manner of getting at it through the plug hole in the bottom of the cylinder casting. These relief valves are provided for both cylinders.

We are indebted to Mr. W. H. Lewis, Superintendent of Motive Power, for the drawings and photographs.

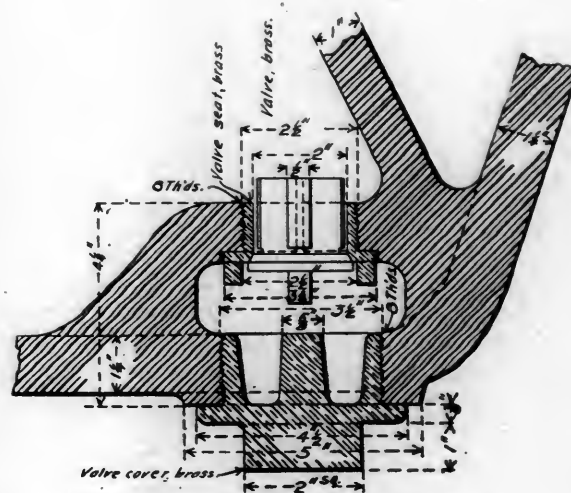
The coal "jimmies," of which the Central Railroad of New Jersey has about 16,000, are long out of date as a business proposition. Mr. Wm. McIntosh, Superintendent of Motive Power of the road, has designed a new coal car of 80,000 pounds capacity, of which 2,500 will be built to give the same coal carrying capacity as was formerly had with the 16,000 small cars.



Sections Showing Valves and Valve Gear.



Section Through Cylinder.



Section Through Relief Valve.

APPLICATION OF PISTON VALVES BETWEEN FRAMES WITH TWO BAR FRONT SECTIONS.
NORFOLK & WESTERN RAILWAY.

INSURANCE FOR EMPLOYEES OF THE ALTON RAILROAD.

Owing to the prohibitory premiums required of railroad employees by insurance companies, the Chicago & Alton has inaugurated a new plan whereby life and accident insurance may be obtained at favorable rates, the idea being clearly stated in the circular, which is as follows:

"The company has entered into a contract with the Aetna Life Insurance Company of Hartford, Conn., the largest company in the United States issuing both life and accident policies, whereby all employees may obtain insurance upon most favorable terms. To aid its employees to secure the best accident insurance at the lowest rates, the company will bear one-half of the premium of the insurance company for all conductors, baggagemen, brakemen, engineers, firemen, bridge carpenters and yard foremen and switchmen; and for all other employees, on account of the lower rates of premium to them, it will bear 30 per cent. of the premium. In connection with this accident insurance the management has also provided for the issuance to those of its employees who may desire it, a term life policy, insuring for a term of not exceeding five years, the employee against death from natural causes; and in aid of the employee desiring the term life policy the company will bear one-half of the premium for the first year, the employee paying the premium for all subsequent years during the term. This term life policy, however, will be issued only to such as hold an accident policy in the Aetna Life Insurance Company, as provided for by this company, and for the same amount. The management offers this opportunity (it is in no respect compulsory), believing the faithful service of its employees, in all departments, warrants it in rendering them substantial aid in the protection of their families and of themselves."

RAILROAD SAFETY APPLIANCES.

It has been practically certain for some time past that an extension of time fixed for the equipment of air brakes and couplers would be desired by a number of roads. The reasons are good in this case, one of them being the impossibility of getting cars into the shops for the time necessary for putting on the attachments, this being due to the unprecedented amount of business on hand. The Interstate Commerce Commission has been very considerate in already extending the time, and the following circular indicates a reasonable attitude toward the present emergency:

Interstate Commerce Commission.

Notice is hereby given that numerous railroad companies have applied to the Interstate Commerce Commission for further extension of time (for the period of a year, or until January 1, 1901), within which to equip their cars and locomotives with automatic couplers and power brakes as provided by Sections 1 and 2 of an act approved March 2, 1893, relating to the equipment of cars and locomotives with safety appliances, and that a hearing upon such applications will be had at the office of the Commission, in the City of Washington, D. C., on Wednesday, December 6th, at 10 o'clock A. M., at which time and place all persons interested will have opportunity to be heard in person or by counsel, whether for or against such extension, and may forward by mail any affidavit, statement or argument bearing upon the question.

By order of the Commission:

EDW. A. MOSELEY,
Secretary.

The annual operating cost of one signal lamp for semaphore or other signals, including oil, care and maintenance, is placed at \$12 by Mr. Frank Rhea, of the Signal Department of the Pennsylvania, in a recent paper read before the Railway Signaling Club.

TEN-WHEEL COMPOUND FREIGHT LOCOMOTIVES.

Northern Pacific Railway.

With Piston Valves on High-Pressure Cylinders.

The Schenectady Locomotive Works have completed 14 ten-wheel, two-cylinder compound locomotives for freight service on the Northern Pacific Railway. They are similar in many of their essentials to previous ones on this road by the same builders. The total weight is 175,500 pounds and that on the driving wheels 134,200 pounds; the heating surface is 3,012.7 square feet, and the grate area 34.22 square feet. This is a very large heating surface for the 10-wheel type, and the largest of which we have record. The boiler is the extended wagon-top type, the first ring being 70 inches in diameter. The driving wheels are 63 inches in diameter and the cylinders 22 and 34 by 30 inches.

The advantages of the piston valve on the high-pressure cylinder were desired and the location of the valve was made such as to admit of using the same design of frames as was applied to earlier engines of this type, of which this road has a number, the descriptions of which were printed in this journal in 1897, page 113, and in 1898, page 65. The piston valve was placed upon the top of the cylinder, with the usual arrangement of the valve motion, because the front sections of the frames are of the two-bar type. It is interesting to compare this arrangement with that of the Norfolk & Western, with two-bar frames, as illustrated on page 386 in this issue. In the case of the Norfolk & Western engine the piston valves were placed between the cylinders, without changing the frames, and in addition to the favorable location of the valves in regard to condensation, this places them in the direct course of the steam in its passage to the cylinders, and permits of using a very direct valve motion. Allen-American valves are fitted to the low pressure cylinders.

There is apparently a marked advantage in piston valves on these engines, aside from the theoretical ones, in the ease of handling the reverse lever, which, of course, has an important effect upon the work of the enginemen. These valves render the adjustment of the cut-off so easy relatively to less perfectly balanced valves that the men pay more attention to the use of the lever, and furthermore the decreased strain on the valve gear may be expected to add to this advantage by giving better port openings. In commenting upon piston valves (the form already referred to on the Norfolk & Western), in his paper before the New York Railroad Club, in September, R. P. C. Sanderson explained some unusually good results from road tests favoring piston valves by saying: "From the time they had handled the engine the first eight miles on the first trip, both men fell in love with the engine, and unquestionably a strong prejudice in favor of this particular engine led them to, perhaps unintentionally, handle it more and more successfully."

These engines have not been running long enough to permit of considering this design as completely beyond the experimental stage, but they have given absolutely no trouble, and the results, so far, are very favorable. The packing is in the form of L rings, with a separate bull ring, such as has been used before. In the photograph a small pipe is seen coming from under the boiler jacket and leading to the top of the casing of the extended piston rod. This is to lubricate the extended rod, and oil is fed to the pipe from an independent sight-feed lubricator in the cab. The two small brass plugs in the side of the piston valve casing cover holes through which the edges of the valves and ports may be seen while setting the valves and without taking the heads down. They are also useful in cleaning the cores at this particular part of the casting, but in the shops it is so easy to take the heads down that they are not necessary in the original setting of the valves or in putting them in order when the facilities for doing so are at hand. The piston valve casing has two relief valves, also



Ten-Wheel Compound Freight Locomotive, Northern Pacific Railway.

A. LOVELL, Superintendent of Motive Power.

SCHENECTADY LOCOMOTIVE WORKS, Builders.

shown in the photograph. These afford relief to the piston valve in case water should be forced into the valve, and they perform the relief that is had by the lifting of the ordinary slide valve. This result has been obtained in England by providing relief through segmental packing rings, which will compress and allow the water to pass through into the exhaust, but on the Northern Pacific engines no working parts are added to the valves themselves to rid them of water.

The driving-wheel brakes are applied to the rear sides of the driving wheels, a practice which should become general because of the relief to the spring rigging, through the change of the brake shoe thrusts from a downward to an upward direction. When placed back of the wheels the application of the braker tends to reduce the load on the springs when the engine is moving ahead. The springs are underhung, after the method employed by these builders. The firebox is above the frames and is depressed at the front end to give as great a depth as possible under the tubes.

The important dimensions and particulars of the engines are given in the following table:

General Dimensions.	
Gauge.....	4 ft. 8½ in.
Fuel.....	Bituminous Coal.
Weight in working order.....	175,500 lbs.
Weight on drivers.....	134,200 lbs.
Wheel base, driving.....	14 ft. 10 in.
Wheel base, rigid.....	14 ft. 10 in.
Wheel base, total.....	26 ft. 8 in.
Cylinders.	
Diameter of cylinders.....	22 and 34 in.
Stroke of piston.....	30 in.
Horizontal thickness of piston.....	5¼ and 4¼ in.
Diameter of piston rod.....	3¼ in.
Kind of piston rod packing.....	Ring 1 in. deep L. P.
Size of steam ports.....	23 in. by 2¼ in.
Size of exhaust ports.....	23 in. by 6 in.
Size of bridges.....	1½ in.
Valves.	
Kind of slide valves.....	H. P. piston valve, L. P. Allen-American.
Greatest travel of slide valves.....	6¼ in.
Outside lap of slide valves.....	H. P. 1¼ in.
Inside lap of slide valves.....	Clearance ¼ in.
Wheels, Etc.	
Diameter of driving wheels outside of tire.....	63 in.
Material of driving wheel centers.....	Cast steel.
Tire held by.....	Shrinkage.
Driving box material.....	Cast steel.
Diameter and length of driving journals.....	9 in. diam. by 11 in.
Diameter and length of main crank pin journals.....	(Main side, 7 in. by 5¼ in.)—6½ in. diam. by 6 in.
Diameter and length of side rod crank pin journals.....	F. & B. 5½ in. diam. by 4½ in.
Engine truck, kind.....	4-wheel swing bolster.
Engine truck, journals.....	6 in. diam. by 11 in.
Diameter of engine truck wheels.....	30 in.
Kind of engine truck wheels.....	Steel tired.
Boiler.	
Style.....	Extended wagon top.
Outside diameter of first ring.....	70 in.
Working pressure.....	200 lbs.
Material of barrel and outside of firebox.....	Steel.
Thickness of plates in barrel and outside of firebox.....	5/16, ¾ and ½ in.
Firebox, length.....	120 3/16 in.

Firebox, width.....	41 in.
Firebox, depth.....	F. 84 B. 71¼ in.
Firebox, plates, thickness.....	Sides, 5/16 in.; back, 5/16 in.; crown, ¾ in.; tube sheet, ½ in.
Firebox, water space.....	Front, 4½ in.; sides, 3¼ to 4 in.; back 3¼ to 4½ in.
Firebox, crown staying.....	Radial, 1½ in. diam.
Firebox, staybolts.....	1 in. diam.
Tubes, number of.....	376
Tubes, diameter.....	2 in.
Tubes, length over tube sheets.....	14 ft. 2 in.
Fire brick, supported on.....	Water tubes, 3 in.
Heating surface, tubes.....	2,772.6 sq. ft.
Heating surface, water tubes.....	32.1 sq. ft.
Heating surface, firebox.....	238.0 sq. ft.
Heating surface, total.....	3,012.7 sq. ft.
Grate surface.....	34.22 sq. ft.
Grate, style.....	Rocking; openings, ¾ in. and 1 1/16 in.
Ash pan, style.....	Hopper, dampers front and back.
Exhaust nozzles.....	5¼ in., 5½ in., 5½ in. diam.
Smokestack, inside diameter.....	18½ in. at top, 16 in. near bottom.
Smokestack, top above rail.....	14 ft. 10½ in.
Tender.	
Weight, empty.....	37,800 lbs.
Wheels, number of.....	8
Wheels, diameter.....	33 in.
Journals, diameter and length.....	4½ in. diam. by 8 in.
Wheel base.....	15 ft. 3 in.
Tender frame.....	10 in. channel.
Tender trucks.....	2 trucks, 4-wheel side bearings on both trucks.
Water capacity.....	4,350 U. S. gallons.
Coal capacity.....	9 (2,000-lb.) tons.
Total wheel base of engine and tender.....	53 ft. 6½ in.

INTERNATIONAL RAILWAY CONGRESS.

Subjects to Be Discussed.

The next meeting of the International Railway Congress will be held in Paris, beginning September 15, 1900, at which the following subjects will be discussed:

Ways and Works.—Nature of metal for rails; rail joints; points and crossings; maintenance of way on lines with heavy traffic; methods of dealing with snow; construction and tests of metallic bridges; transition from a rising to a falling gradient; preservation of timber; ballast; creeping of rails.

Locomotives and Rolling Stock.—Exhaust and draught in locomotives; locomotives for trains run at very high speed; stability of locomotive axles; banking, piloting, or double heading; purification of feed water of locomotives and use of disinfectants; use of steel and ingot iron in construction of locomotives and rolling stock; brakes and couplings of carriages and wagons; economical size of goods trucks or capacity of freight cars; electric traction; automotor vehicle.

Traffic.—Train lighting; handling and conveyance of broken loads; long-distance goods trains; economical interlocking apparatus; automatic block system; signals for repeating visible signals; use of the telephone; safety appliances for preventing collisions arising from runaway wagons; sorting by gravitation; distribution of rolling stock.

General.—Accounts; railway clearing houses; grouping of goods; technical education of railway servants—appointment and promotion; co-operative societies and stores under railway management; facilities for customs inspection.

Light Railways.—Influence of light railways on national wealth; means of developing; main lines crossed by light railways; conveyance of farm produce to stations; carriages and wagons for light railways; warming of carriages.

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Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Special Notice.—As the AMERICAN ENGINEER AND RAILROAD JOURNAL is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 20th day of each month.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

The paper may be obtained and subscriptions for it sent to the following agencies: Chicago, Post Office News Co., 217 Dearborn Street. London, Eng., Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane. E. C.

We are not responsible for the poor character of some of the engravings in this issue. This is due to a strike among the engravers.

It has been a common error that a wide firebox necessarily meant an inordinately large grate. On this point Mr. Forsyth is very clear, on page 347, in our November issue. The advantage of greater width is that the necessary area may be obtained without excessive length. Whether the grate is large or small, the disposition of its surface is much better if it is not rigidly limited in width to the customary distance. There is no objection to, but rather a decided advantage in, a long firebox, because of its value as a combustion chamber, but it is not necessary to insist upon making the grates as long as the firebox.

It is interesting to compare the effects of Mr. J. Snowden Bell's paper on Wide Fireboxes before the Western Railway Club in 1895, with that of September last on Short Front Ends, before the same organization. Wider fireboxes are looked upon

with greater favor, and for several reasons, which Mr. Bell has urged for a long time. The spark losses due to the draft which is necessary to use with an over-worked grate are beginning to be appreciated. The possibilities of reducing the proportions of the smoke nuisance, and possibly also the reduction of the number of staybolt breakages will all have their influence and a radical change of opinion as to the best shape for fireboxes is very probable. This must be gratifying to Mr. Bell, who has been ahead of his time on this subject.

In summing up the relative advantages of cast steel and wrought iron for locomotive parts where it is possible to use castings it has been said that the cost of machining the castings is so high as to increase the expense of castings above that of forgings. This criticism has been applied particularly to locomotive frames, but the reason for this is not clear. In fact, if frames are properly designed the cost of finishing may be the same in both materials or it may be even cheaper in steel. The amount of material to be removed in finishing may be reduced to a minimum by arranging the portions that are to be machined so that they will project above the other surfaces and the high ones only will be dressed. It is not necessary to finish the entire surface of a cast steel frame on this account, whereas a forged frame cannot be made with the finished portions projecting above the others without greatly increasing the cost of the forge shop labor. Well designed steel castings of good material do not break and there seems to be no reason for delaying to accept this material for frames. There is in fact good reason for using it.

It has been said in rather a blood-curdling way that a large number of first class and some second class funerals among traffic officials are necessary to a solution of the problem of a standard freight car in this country. It is probable, as Mr. Rhodes said last month before the Western Railway Club, that the solution will not be more difficult than those which have been the means of attaining the present standard air brake and freight car coupler and the financial benefits to be had from the really standard car are great enough to entirely overshadow these acquisitions, important as they are. Much hope may be had from the fact that motive power, operating and finally traffic officers agree in the desirability of this step and the result does not seem to be in quite the remote distance that it occupied a few years ago. The question interests all departments and the sincerity and perseverance of Mr. Rhodes which has done so much to develop the present standard air brake may be counted a powerful influence in this question. The Master Car Builders and the American Railway Associations have brought the problem forward and if traffic officials do their part the only remaining question will be to determine the dimensions. Difficult as this may be, it is to say the least, not worse than the question of couplers. The cross section of the car should be determined by the clearances of interchange roads and if the clearances on a few roads are found to limit the dimensions to an important extent for the whole country it is probable that the financial advantages to be gained will induce them to increase where it can be done without extraordinary expense.

"Shall we adopt yellow lights for the caution indication of distant signals?" is a question which is seriously troubling a number of operating officers who are seeking to improve their systems of signaling. The new color has been adopted by the New York, New Haven & Hartford and by the Canadian Pacific. Other roads have changed their semaphore castings and are ready to change from white to green, as an "all clear" signal. They are watching the results of the use of yellow for the distant signal, hoping to find it satisfactory. Opinion is not unanimous in favor of yellow, where it is in use, and several objections have been raised, among which is that it is not sufficiently distinctive and may be mistaken for a

smoky white light. We do not believe there is serious danger of red being mistaken for yellow, and if yellow is mistaken for red, no danger is involved. It has been said of the locomotive runners on the New Haven road and their favorable opinion of yellow signals, that they are so glad to have the green "all clear" signal that they are quite ready to put up with the disadvantages of the new color. This is probably the best way to look at the whole question of the change, viz., it permits of using the only safe color for "all clear," the disadvantages are not serious, and the men who use the signals are satisfied. In view of the glaring and often positively dangerous inconsistencies so often seen in railroad signaling, it seems strange that absolute perfection in the system of colors for night signaling should be considered a necessity. The yellow light is consistent and is a part of a logical system, the men who use it like it, there appears to be no trouble in using it, and it seems to be a plan which may be adopted with confidence.

LOCOMOTIVE STUDY IN TECHNICAL SCHOOLS.

There certainly is a revival of interest in technical school instruction in regard to the locomotive, and we are glad to print the communication by Mr. E. L. Coster, in another column, in which a suggestive criticism is offered. Our correspondent is connected with an engineering college, and after giving considerable thought to the subject, presents a view which will find ready endorsement. The locomotive requires special treatment. It is progressing, perhaps, more at the present time than at any period in its history, and by all means the technical school is the best place for future motive power officers to obtain their ideas as to the necessities and possibilities of the locomotive problem. This branch of engineering offers a wide field for good work, and the question is how to give students the best idea of it. We believe that the best educational preparation in this connection is a good course in mechanical engineering, with the addition of a generous amount of time to this special subject. This should include the application of engineering to the locomotive as a steam motor and the use of information obtained in other courses in regard to the strength of materials, applied to the peculiar conditions, but the subjects which appear to be most often overlooked are the possibilities and limitations which this rigorous service offers. The business questions of train operation should be brought in, and when this is done it is clear that the subject becomes one worthy of the best thought of those who are directing technical education. It is easy to run too far toward testing and too deep into past history, and it is difficult, in the time available, to go too far into principles and into correct practice in details. We speak of correct practice in details with feeling, because this is a phase of the subject which can be given at school better than anywhere else, and yet it is known that in some cases really bad practice is presented to students as illustrating how locomotives are built. The need is for instructors who thoroughly understand what is wanted in locomotives, who can show what ought to be done and what is done in the most successful examples. It is difficult to obtain such instructors, but we do not believe it to be impossible for the necessary knowledge to be obtained by men who have selected teaching as their vocation. Examples of such men who are very successful might be mentioned. It is necessary for the schools to first appreciate the importance of the subject and then to provide for the course with the broadness which its character demands. The remaining question is to arrange the course to give the best that school instruction can give in the time allowed. Several technical schools are now considering the problem in a promising way. We desire to heartily commend and encourage the movement.

CYLINDER POWER OF COMPOUND LOCOMOTIVES.

By G. R. Henderson.

Assistant Superintendent Motive Power, Chicago & Northwestern Railway.

There is one point in connection with compound locomotives that is seldom referred to, the ratio of tractive power to weight as compared with simple locomotives. Examination of a number of heavy two-cylinder compounds reveals the following

values for the ratio $\frac{Pd \cdot S}{DW}$ when

P = steam pressure,
d = diameter of cylinder,
S = stroke of piston,
D = diameter of driving wheels,
W = adhesive weight,

all being expressed in pounds and inches:

Working Compound.	Working Simple.
.180	.315
.185	.270
.200	.295
.210	.310
.245	.360
.250	.350
.255	.370
.265	.385

These values were computed as follows:

Working simple: P = boiler pressure and d = diameter of high-pressure cylinder.

Working compound: $P = \frac{\text{Boiler pressure}}{\text{Cyl. Ratio} + 1}$ and d = diameter of low pressure cylinder.

The results are, of course, the ratio of theoretical tractive power to adhesive weight, and may be correctly used for making comparisons, though not for expression of actual pulling power. As long ago as 1887 a committee of the Master Mechanics' Association recommended that the above ratio be 0.26 for freight engines. However, with improved sanding apparatus, good results may be obtained with a ratio as high as 0.31, and there are many locomotives in use in which the ratio is from .28 to .30.

This being the case, it is at once evident that the simple locomotive has an advantage in power over the compound. The reason for this arrangement is also apparent when we remember that if we exceed the value 0.30, we get a "slippery engine," and this requires careful handling, so that most of the compounds above listed would be inclined to slip their wheels when starting or operating as simple engines. In some recent tests on heavy grades and curves with engines having ratios of 0.25 and 0.37, when working compound, the wheels would slip on curves; and when working simple, it was necessary to use sand on straight track. Of course the lever was in the corner and the engine was exerting its maximum power.

Now there are many cases where this is no disadvantage, but is perfectly satisfactory, and makes a logical arrangement. For instance, let us consider a rolling profile with level stretches and an occasional hill of easy gradient to be passed. In this case the engine may be so loaded that it will be necessary to operate it as a single expansion engine in starting and ascending the grades, but on the levels it may be used in the compound position and in nearly full gear. The maximum tractive force will then be needed only at starting and passing the critical points.

But now let us take an entirely different condition, and assume that the engine is to be used exclusively in pusher service on a heavy mountain grade. In the course of its work it will be expected to pull every pound possible for perhaps an hour and then drop back down the hill light and possibly wait several hours for the next train to be made up. Under these conditions the tractive power should be fully up to the adhesion. If it is not, the weight of the engine is not fully utilized. In this service the simple engine with cylinders to give a tractive power (theoretical) of 0.31 of the adhesive weight

has decidedly the advantage. Of course our compound engine may be worked simple, but even if it is not too slippery for satisfactory performance the extra cost and mechanism of the compound feature is at least unremunerative. It is true that this simple engine will burn more coal than a compound, but if the case is as above represented it will be using steam but one-fourth or one-fifth of the time and the extra hauling capacity will probably be considered of more value than the saving in fuel. If compounds are insisted upon for such work it seems advisable to call attention to the fact that the cylinders should be proportioned to obtain the full advantage of the adhesion, when compounded, and some reducing valve or other arrangement provided, so that when working simple little or no increase in power will be experienced, but merely the proper steam admission obtained at both sides in order to enable the engine to start in any position of the cranks.

LOCOMOTIVE ROAD TESTS.

Norfolk & Western Railway.

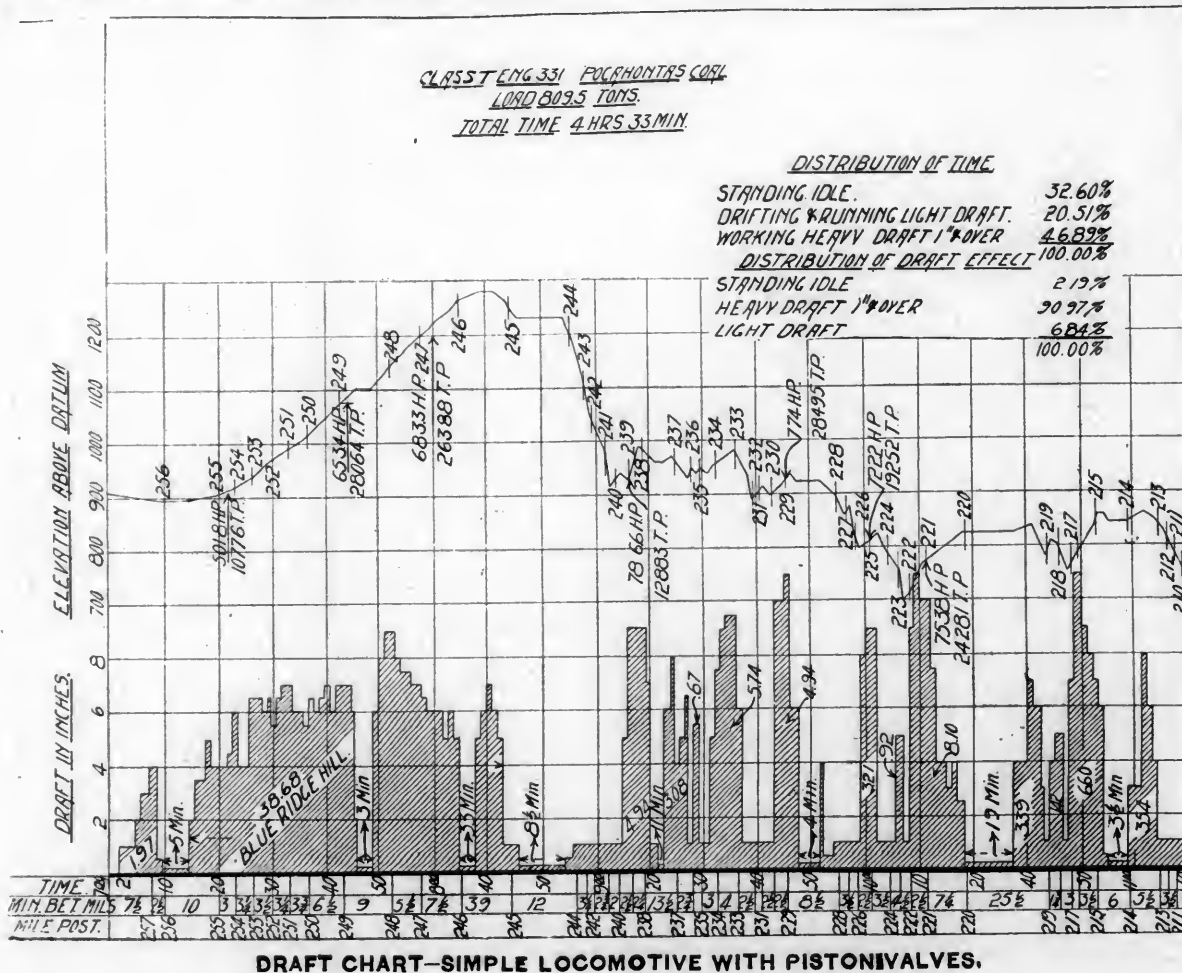
Mr. W. H. Lewis, Superintendent of Motive Power.

We are indebted to Mr. W. H. Lewis, Superintendent of Motive Power, for the drawings of the piston valves shown on another page, and also for records of an interesting series of road tests for fuel consumption in several locomotives on the Blue Ridge Mountain grade, the chief object of which was to ascertain the relation between the fuel consumption and the work performed. The question was whether an increase in tonnage hauled would result in a decrease in the consumption of fuel burned per 100 ton miles. It would seem plain that any increase in tonnage beyond the economical rating of the locomotive must be at the expense of economy of fuel, and that a decrease of tonnage below the economical rating would be correspondingly wasteful, the point to be determined being

the economical rating of the engine. It is evident that this depends upon local conditions to such an extent as to make it possible to ascertain this rating only on a given portion of the road. The actual economy of operation due to hauling the maximum possible loads was not considered in this work.

When the subject was first presented a theoretical solution was attempted by computing the tractive force and theoretical tonnage rating of a locomotive of given dimensions for certain grades and known rates of combustion per square foot of grate and heating surface and evaporation value per pound of coal. The steam used per hour was then calculated at various speeds with cut-offs at 30, 60 and 90 per cent. The results seemed to indicate that the coal consumption increased very rapidly with the increase of tonnage and was greatly in excess of the average number of pounds per 100 ton miles for the lesser lading. For example, a (Class G) engine, with 400 tons, on a 1 per cent. grade, at a speed of 10 miles per hour, consumed 27 pounds of coal per 100 ton miles, while with 600 tons the consumption was 39 pounds, and for 800 tons 56 pounds per 100 ton miles. In other words, doubling the tonnage more than doubled the consumption of fuel per 100 ton miles.

The report states that in order to test the correctness of this theoretical calculation it was decided to make a service test, selecting, first, a Class W engine, with 21 by 30-inch cylinders; weight of engine, 150,000 on driving wheels; drivers, 56 inches in diameter. Second, a Class T simple engine (with slide valves), cylinders 21 by 24; weight, 125,000 pounds; drivers, 56 inches in diameter. Third, Class T simple (with piston valves), cylinders, 21 by 24; weight, 125,000 pounds; drivers, 56 inches in diameter; and fourth, Class T compound, with cylinders 22½ and 35 by 24; weight, 125,000 pounds; drivers, 56 inches, with steam pressure of 200 pounds for all the engines. That portion of the road between Roanoke and Lynchburg (over the Blue Ridge Mountains), with a maximum grade of 66 feet to the mile, was selected. The engines were provided with indicators and vacuum gauges to record the amount of



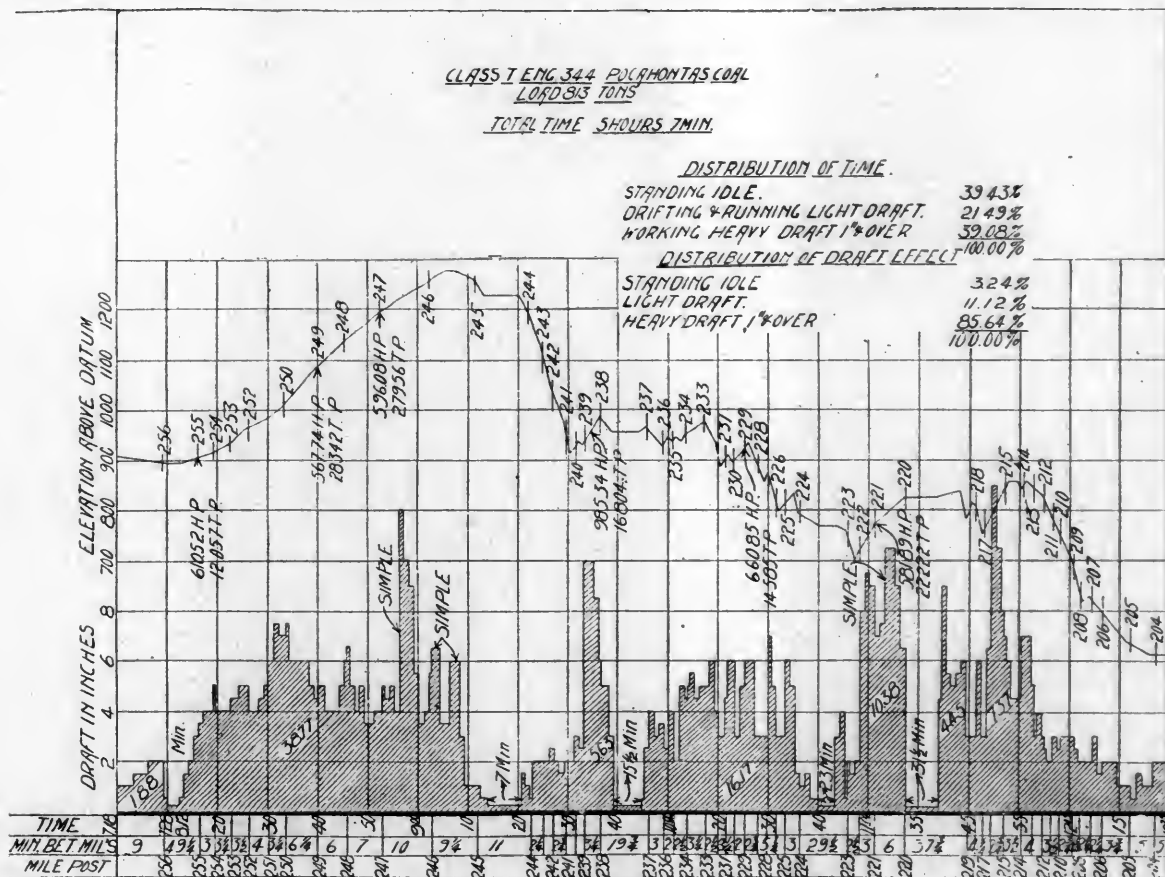
vacuum developed in the smokebox and water meters to record the water consumption. The loose coal in the coal space was accurately weighed and the surplus was sacked, each sack containing 100 pounds. As the water meters proved unreliable, the tank was calibrated and the readings were sufficiently accurate to insure reasonably correct results. Five preliminary trips were made with different tonnage to determine approximately the proper tonnage and to get everything in good working order. The plan outlined for the test was to first load the engine below the normal tonnage rating and gradually increase the rating each trip, keeping the conditions the same as nearly as practicable. The following is quoted from the report:

"Engine No. 809 (Class W), in good condition, was given a train of about 150 tons below the normal rating and tonnage increased on subsequent trips to about 100 tons above the normal rating. Duplicate trips were made with each tonnage to insure average results. A similar series of tests was made with each of the engines above mentioned, with the same engineman, fireman, conductor and brakeman, the train leaving at the same time each day, and train dispatchers gave the train as uniform movement as possible. The same tender was used on the different engines during the entire series of tests. Indicator diagrams were taken at eight points on the run, representing the ruling grades, to ascertain the tractive power and horse-power developed by the engine. In addition to indicator diagrams, readings were taken from the draught gauge in the front end at frequent intervals during the trip, noting the variations in the draught as the work of the engine ran from extreme conditions to that of drifting with the throttle closed. The changes in the draught gauge were noted according to time intervals, and the time also noted at the passing of each mile post. A graphical chart showing the amount of draught during the entire trip was compiled from these data, the chart showing the stops in minutes, and the lines enclosing the amount of draught carried on from minute to minute may be called the total draught effect, which, on

the chart, is distributed to each pull. For instance, these charts show the amount of draught effect for a pull on Blue Ridge Hill to be in one case 44.9 per cent. of the entire draught effect for the entire trip, and we reasonably assume that very nearly that proportion of the entire coal burned from start to finish was consumed on that portion of the run, thus showing where the coal had been burned. This is taken on the proposition that the amount of coal burned must be in close relation to the amount of draught. It was proved by observation that this was approximately correct, as the amount of coal burned, by accurate measurement, corresponded very closely to the chart. The chart shows the tractive power and horse-power at the points where indicator cards were taken. The chart also shows a line produced by extending the mile posts to a scale height corresponding to their elevation on the road profile, thus producing a time interval profile which agrees with each draught effect. In other words, when the train is raised a known number of feet, in a given number of minutes, as shown on the profile, under this rise will be found the proportionate amount of draught necessary to overcome the resistance.

"It was found that a lading of 1,120 tons, exclusive of the weight of the engine and caboose, could be considered a full maximum load for Class W, 890 tons for Class T simple and Class T compound (two cylinder) up Blue Ridge grade; and it was found that with this lading, with the engine working at full stroke, the pneumatic sanding device was insufficient to hold the engine to the rail, and it became necessary to use the hand sanding device on the hardest pull. The engines were working at their maximum power, the tractive power exerted in some cases was as high as 27.6 per cent. of the adhesive weight of the engine, and as the highest usually considered available is about 22 per cent., it is plain that the engines were doing all that could be expected.

"The pounds of coal per 100 ton miles for two trips were .098 and .101, and for two others the pounds of coal were .121 and .117 respectively, an increase of about 20.2 per cent.



coal burned per ton mile for an approximate increase of 10 per cent. in tons hauled.

"Referring to the draught effect diagrams, as stated above, it appears that 44.9 per cent. of the entire coal burned on this trip of 54 miles was consumed in a distance of 12 miles from Roanoke to the top of the Blue Ridge. It is plain that if the grade was uniform for the entire distance the consumption of fuel would have been more than four times the amount actually consumed. Realizing that the speed of the train was a very important factor, special effort was made to keep each trip as nearly a uniform speed as possible.

"Inasmuch as certain ruling grades between Roanoke and Lynchburg restricted the tonnage rating between these points so that it was impossible to increase the rating materially above the maximum rating without doubling, we decided to continue this test on the Norfolk Division, between Crewe and Lambert's Point (133 miles), where the low grade would permit of a greater over load in tonnage and would enable us to better observe the effect so far as fuel consumption was concerned. We selected Class T engine No. 326, the normal rating of which was 2,000 tons, over this portion of the road. Ten trips were made with this engine, starting with a tonnage of 2,016 and increasing gradually each trip until we reached a tonnage of 2,434 tons. This test developed the fact that while the total pounds of coal burned per trip increased slightly with the increase of tonnage, the pounds of coal per 100 ton miles was approximately unchanged, due to the fact that the profile of this division is a gradually descending grade in the direction of traffic, with a succession of short momentum grades, with very little level track, which permitted an acceleration through the depression sufficient to carry the train over the heavy pulls. This was made possible by the assistance given by the train dispatcher in making favorable meeting points and not stopping at stations where the grade was unfavorable.

"The conclusions derived from this test would seem to bear out the assumption that an increase in tonnage hauled beyond the normal or economical rating results in an increase in fuel burned per 100 ton miles, where the grades require that engines should be worked at from 30 to 90 per cent. cut-off, and that the amount of fuel burned is in direct proportion to the draught effect, and that carefully conducted service tests are the only reliable means for securing data for establishing the proper tonnage rating for locomotives."

The graphical diagrams of the draught effects are novel and were worked out by Mr. C. A. Seley, Mechanical Engineer of the road. The report includes a number of these, two of which are reproduced, one taken from the record of Class T engine No. 331, which is a simple engine with piston valves, and the other from engine No. 344, a Richmond compound. Comparing the charts taken from the two simple engines the differences appear to be chiefly due to the lading. The engine with piston valves seemed to do its work much easier than the other under all conditions, which is attributed to the reduced load on the valve gear, which resulted in better port openings. The chart of the compound illustrates a noteworthy feature in the relatively high degree of vacuum while drifting. It is evident that this compound was not fitted with the recent improvements instituted by the Richmond people and illustrated in our September issue. The draught while drifting is high when compared with that of the simple engine, running up to 2 and 3 inches, as compared with $\frac{1}{2}$, $\frac{3}{4}$ and 1 inch for the simple engine. This results in unnecessarily active combustion and steam making when it is not desired, and in consequent loss. The compound was worked as a simple engine in several places, which are indicated on the chart.

These draught charts afford a very interesting method of analyzing the consumption of the fuel and we commend them for their novelty. From them the distribution of the fuel consumption may be studied, including the proportion of effect due to standing idle, working lightly and working hard. These curves show the relative amounts of work done on the hills

and in descending grades. They also include the horse-power for each indicator card and the speed over even portions of the road.

These tests should not be misunderstood. They show an increase in the amount of fuel burned per ton mile unit when the engine is run at a point beyond the most economical cut-off, but this work treats of the fuel alone and does not take into consideration the operating questions. Certain charges are constant for a trip of 100 miles at 10 miles per hour, regardless of the train load. When these charges are considered, the greatest economy of operation is found when the engine is loaded to its full capacity, unless possibly the price of fuel should be abnormally high and train crew wages abnormally low. The operating question is the final one in such a case, and the increase of the fuel consumption, due to hauling heavy trains, may not be bad business policy, but it may be exactly the reverse.

RAILROAD SIGNALING.

Progress in railroad signaling is indicated to a certain extent by the relative amounts of attention given to the various topics of discussion at the recent annual meeting of the Railway Signaling Club, held in Boston. The subjects introduced by the papers presented were: Normal Safety vs. Normal Clear Systems of Automatic Signals, by A. J. Wilson; Progress in Signaling, by H. M. Sperry, and the Possibilities of Three-Position Semaphore Signals, by Frank Rhea.

Mr. Sperry's paper on progress in signaling was an admirable review of the state of the art, and was suggestive in regard to recent improvements in constructive details which should find general use in the future. It was the best paper presented and worthy of a thorough discussion which it did not receive, but it developed the fact that the most important subject in signal practice is that of the proper color for use at night on distant signals. The recent adoption of yellow for this purpose on the New York, New Haven & Hartford R. R., and the fact that the meeting was held in Boston offered an opportunity for the members to inspect the color under practical conditions which was taken advantage of.

The result was a favorable impression upon most of the members. The best opinions seemed to favor the new plan. Objection was made that yellow was not sufficiently distinctive; this, however, was not a source of danger, because it was possible that the new color would be mistaken for red under certain combinations of atmosphere and distance, but it was not likely that a red light could ever be mistaken for yellow. At short and even moderately long range, however, the distinction was sufficient, even if in doubt at a distance. The mistakes would therefore be likely to occur upon the safe side. This is the ground that we have taken in regard to the yellow distant signal light, and it was confirmed by the discussion.

It may therefore be said that the cause of the yellow light has gained ground. It is highly important that the color should be exactly right and that the glass should be made with extreme care. In connection with the shade of color it should be stated that Mr. C. Peter Clark, General Superintendent of the N. Y., N. H. & H. R. R., has found that the enginemen prefer a decided tinge of red in order that there may be no question of the doubt being on the right side in case of thick weather. The new color has not yet gone through a winter, and it is possible that valuable experience may be had by viewing it through snow.

The first of the papers introduced the question whether block signals should stand at "danger" positions or at "safety" under normal conditions with the track governed by the signals unoccupied and ready for a train to proceed. To the enginemen there is practically no choice, because with both systems properly installed and in working order, they cannot see any differ-

ence. It was argued that the normal danger had two decided advantages. First, the signals were liable to freezing up in sleet storms and it was safer to have them held in the danger position, and if they stood normally at "all clear" they might freeze and give misleading information of a dangerous character. Second, the signals are held at "all clear" by the battery currents, and there was an important economy in battery material and supplies in the normal danger system in which the batteries were only used while the signals were held at "all clear" for the passage of trains.

The discussion showed no lack of positive opinion, but it was clear that those who had but one system favored it, and considered it the safer and better, while those who had both favored the normal danger plan because it was consistent with the principle followed as far as possible in mechanical interlocking. One seeking information as to which system is best would get no help but would feel free to use either in the confidence that he had the support of well-formed opinion.

Other subjects were discussed, but these are not only the most important, but the most interesting to motive power men.

COMPRESSED AIR LOCOMOTIVE.

H. K. Porter & Co.

The accompanying engraving is from a photograph of a compressed air locomotive, built for the Aragon Mine, Norway, Mich., by H. K. Porter & Co., of Pittsburg.

The new plant, as installed for the Aragon mine, to replace haulage by mules, consists of a three-stage air compressor having a steam cylinder 14 by 16 inches. The air cylinders

of 1,000 tons in ten hours. The following table gives the dimensions of the locomotive:

Gauge of track.....	23 in.
Drivers.....	24 in.
Cylinders.....	7 by 12 in.
Main rod.....	47 in. long.
Weight on drivers.....	14,000 lbs.
Wheel base.....	48 in.
Length over all.....	13 ft.
Height over all.....	62 in.
Width over all.....	50 in.
The motor to work on curves of.....	20 to 25 ft. radius.
Air tanks, one.....	36½ in. outside diam.
Steel.....	Shell, ¾ in.; heads, 1½ in.
Joints, longitudinal.....	Butt, double welt, octuple riveted.
Joints, transverse.....	Lap, double riveted.
Auxiliary reservoir, capacity.....	1.6 cu. ft.
Auxiliary reservoir, working pressure.....	140 lbs.
Main reservoir, working pressure.....	700 lbs.
Main reservoir, capacity.....	.65 cu. ft.

The torpedo boat destroyers, with Parsons steam turbines, which are now being built for the English navy, will be 210 feet long between perpendiculars. Their extreme beam will be 21 feet and moulded depth 12 feet 9 inches. The displacement at a draught of 5 feet 4 inches will be 320 tons. The propeller shafts will be four in number, each having two screws, and operated by two separate sets of turbines. The outer shafts will be driven by high-pressure and the inner ones by low-pressure turbines. The inner shafts will also have small reversing turbines, to drive the boats astern. The total power will be 10,000 indicated horse-power, which is expected to give a speed of 35 knots while going ahead and 16 knots while going astern. The auxiliaries for the air pumps will be turbines and the circulating pumps will be driven by reciprocating engines. The weight of the boilers will be 100 tons, 15 cwt., that of the machinery in the engine room 52 tons, 6 cwt., and that of the propellers and shafting 7 tons, 14 cwt. This will give a weight of machinery and boilers of about 30 pounds per



Compressed Air Locomotive.

Built by H. K. PORTER & Co.

are 10½, 7¾ and 2½ inches in diameter. The compressor, at normal speed, will compress 125 cubic feet of free air per minute to 800 pounds pressure, and is connected to two storage tanks, 3 by 17 feet, from which the compressed air is carried down a shaft 750 feet, through a 3-inch pipe, thence to charging stations placed at convenient points in the mine, making the longest haul for round trip about 4,000 feet, and the shortest about 1,200 feet.

The weight on drivers of the locomotive is 14,000 pounds; it has four driving wheels 24 inches in diameter, and cylinders 7 by 12 inches. The air pressure from the locomotive tank is reduced from 700 pounds to 140 pounds, the required working pressure. The locomotive is capable of pulling on a level with one charge of air, a train of 30 tons for a distance of 4,500 feet, and it will return with 10 tons, the weight empty. The maximum power of the motor, on level mine track, is 100 tons. Four trains of 20 cars each can be run every ten hours from the ten different points of the mine, making a hauling capacity

indicated horse-power. The corresponding weight per indicated horse-power in recent boats of this class, with reciprocating engines, is about 54 pounds.

When scrap steel rails are worth more than new rails just from the rolls the condition of the rail market may be considered peculiar. Of course new rails are always worth more than old ones, but it is a curious fact that one large rail concern in Pennsylvania is now furnishing rails to a railroad on an old contract, entered into before the advance in prices, at \$19.00 per ton, and the same road is furnishing old steel rails to the steel works at \$21.00 per ton.

Just as we go to press a despatch is received stating that one of the new 10-wheel passenger locomotives of the Lake Shore & Michigan Southern (see November issue, page 343), made a run, November 24, of 186 miles from Buffalo to Cleveland, in 3 hours, 23 minutes, with 8 cars, making 5 stops between the terminals.

the trial of the petticoat pipe it was found that the exhaust was very jerky and intermittent, and on comparing the results with those of older engines, which did steam well, the only factor which seemed to have much bearing on the question was that in the older engines, which were low, the stack was materially longer and apparently the exhaust went through and beyond the short stack without completely filling it. When the petticoat pipe was removed and the length of the stack increased, an improvement in the action was immediately noticeable, so great an improvement having been secured as to lead to the decision not to return to the use of the petticoat, no matter what the service or type of the engines.

The simple facts in the case are stated here without attempting an explanation or suggesting a criticism of the excellent work of the Master Mechanics' Association Committee. It seems proper to draw the conclusion, however, that the petticoat pipe does not make up for the detrimental effect of a short stack. Support for this conclusion is given by recent experience with some large compound locomotives with which a great deal of difficulty was experienced when running slowly, owing to the intermittent effect of the exhaust. These compounds were fitted with petticoat pipes when they gave this trouble and when changed in accordance with this idea they were entirely satisfactory.

The drawing shows an extension of the stack downward into the smokebox, with a flaring mouth, or a union of a petticoat pipe and stack, with no open space between them. The drawings do not require explanation as they show the front end and also the stack, giving its form, diameters and height. This arrangement is found to be almost perfect in its self-cleaning qualities, hardly a quart of cinders being found in the smokebox after a long run. The area of the netting is large and the draft is found to be uniformly distributed over the flue sheet. The stack extension is not by any means a new idea, but it probably never before had such an opportunity to show its importance as at present, with large boilers and short stacks.

In a letter received after this description was written, Mr. J. Snowden Bell said: "I quite agree with those who hold that the inward extension of the stack is the coming plan, and indeed it seems indispensable with the present large and high boilers. The fact, however, is that the difficulties due to the shortening of stacks were appreciated long prior to 1895." Mr. Bell puts the date at 1860 in his recent paper before the Western Railway Club.

PERSONALS.

F. E. Clark, President of the Boston & Lowell, died very suddenly at his home in Lawrence, Nov. 7, aged 69 years.

Mr. A. B. Pirie has been appointed Master Mechanic at the Havelock Shops of the Burlington & Missouri River Railroad.

Mr. W. H. Harrison, Master Mechanic of the Baltimore & Ohio, stationed at Newark, O., has resigned and will go to Chicago.

Mr. C. R. Tunks has been appointed Master Car Builder of the Lake Shore & Michigan Southern, with headquarters at Adrian, Mich.

Mr. Robert S. Bradley has been elected President of the Central Massachusetts, in place of Mr. Samuel H. Aldrich, who declined a re-election.

Mr. Le Grand Parish has been appointed Master Car Builder of the Lake Shore & Michigan Southern, at Englewood, vice Mr. A. L. Kendall, resigned.

F. J. Kraemer has been appointed Master Mechanic of the Southern Division of the Burlington & Missouri River, with headquarters at Wymore, Neb.

Mr. Lawrence K. Frederick has been elected Vice-President and General Manager of the Erie and Central New York Railroad Company, with headquarters in Cortland, N. Y.

Mr. O. H. Jackson, Superintendent of Motive Power of the Phenix, Santa Fe & Prescott, has resigned on account of ill health and has returned to New York City to reside.

Mr. D. F. Crawford has been appointed Superintendent of Motive Power of the Pennsylvania lines west of Pittsburg,

Northwest system, to succeed Mr. G. L. Potter, promoted. Mr. Crawford has heretofore been Mr. Potter's assistant.

Mr. J. J. Hill, President of the Great Northern Steamship Company, has resigned his position with this company and Mr. Darius Miller, Second Vice-President of the Great Northern, will succeed Mr. Hill as President of the steamship company.

William F. Durfee died in the State Hospital at Middletown, N. Y., Nov. 14th. Mr. Durfee was one of the pioneers in the development of the iron and steel industry in the United States. He was a member of the American Society of Mechanical Engineers, of which he had been a Manager from 1883 to 1886 and Vice-President from 1895 to 1898.

Vice-President Hall, of the New York, New Haven and Hartford, has been elected President of that company, to succeed Mr. C. P. Clark, resigned. President Hall is fifty-eight years old; he graduated at Yale College in the class of 1866, after taking very high literary honors. He graduated at Columbia Law School in 1868, and was admitted to the New York bar in the same year. He was appointed a Judge of the Supreme Court in 1889, and would probably have been promoted to the Supreme Bench but for his resignation of his Judgeship in 1893 to take the first Vice-Presidency of the New Haven Railroad, which he has held up to this time.

Mr. G. L. Potter, heretofore Superintendent of Motive Power, Pennsylvania Lines West of Pittsburg, Northwest system, has been promoted to the newly created office of General Superintendent of Motive Power, Pennsylvania Lines, with headquarters at Pittsburg. Mr. Potter reports to the General Manager, and has the direct supervision and control of the motive power department in so far as is necessary to insure the efficiency of the equipment. He has charge of all tests and experiments, and directs the various shops and makes such recommendations to the General Manager or direct to the Superintendents of Motive Power, as he deems necessary for the efficiency and economy of the service. This outline of his new duties is taken from the official announcement of his appointment.

Mr. L. R. Pomeroy, who is well known as the representative, in the East, of the Cambria and the Latrobe steel companies, has resigned this position, which he has filled for the past seven years, to become Assistant to the General Manager of the Schenectady Locomotive Works. Mr. Pomeroy spent about twelve years in accounting work and in 1886 became Secretary and Treasurer of the Suburban Rapid Transit Railway of New York City, which afterward became a part of the Manhattan system. He spent two years in the sales department of the Carnegie Steel Co., after 1890, and then took up the representation of the two companies, which he now leaves. He has been very successful in his work, and has had an important influence in securing improved practice in locomotive details, with particular reference to axles, piston rods and crank pins. His accounting experience, wide acquaintance and knowledge of locomotive practice will make him a valuable officer to the Schenectady Locomotive Works, and it will be difficult to fill his position with the firms whose employ he leaves.

Mr. O. H. Reynolds, who is well-known to the readers of this journal, has been appointed Mechanical Engineer of the Dickson Locomotive Works at Scranton, Pa. His ability and experience in the motive power departments of important railroads, coupled with clear ideas of locomotive design and thorough knowledge of shop methods and operation of locomotives on the road, render the selection a wise one. He is a safe and intelligent designer and will be a valuable addition to the staff which he joins. That railroads need men of his experience and qualifications is the greater reason for congratulating the Dickson people. Mr. Reynolds began railroad work as an apprentice in the shops of the Michigan Central, where he remained for several years after completing the apprenticeship. His most important railroad work was on the Northern Pacific as Mechanical Engineer, a position which he filled for several years. He came to New York about three years ago to join the editorial staff of "Locomotive Engineering." After severing his connection with that journal he assisted in editing the "American Engineer and Railroad Journal" until he was called to the motive power department of the Central Railroad of New Jersey, which he leaves for his present position at Scranton.



Schenectady, Consolidation Pushing Locomotive, Delaware & Hudson Co.

CONSOLIDATION PUSHING LOCOMOTIVE.

For Fine Anthracite Coal.

Delaware & Hudson Company.

Exceptionally Powerful Boiler for the Weight.

This locomotive is one of six built by the Schenectady Locomotive Works for the Delaware & Hudson Company, and used in pushing service. The design resembles in appearance the one illustrated in our August issue, page 247, but the new ones are very much heavier and more powerful. They are to burn fine anthracite coal and have very large grates, with 90.19 square feet of grate area. The cylinders are 22 by 28 inches, and the driving wheels, which are of cast steel, are 50 inches in diameter. The driving wheels are not of the same weight, the main wheels being made heavier and stronger than the others. The rods are of light and fluted section, the driving axles have enlarged wheel fits, and the frames are of cast steel. The details are not novel, but the real feature of the design is in the very large heating surface in view of the limit of the total weight of the engine. The total weight was limited to 176,000 pounds, and efforts were made to secure as much heating surface and grate area as possible without exceeding the limit. The total heating surface is 3,348 square feet, which, with the exception of the Baldwin compounds for the Lehigh Valley (American Engineer, December, 1898, page 395), and the mastodon for the Illinois Central (October, 1899, page 315), is the largest total heating surface in locomotive practice of which we have record. The very large consolidation locomotive for the Union Railway has a total heating surface of 3,322 square feet, with an 80-inch boiler, and a total weight of 230,000 pounds; the new mastodon for the Illinois Central has 3,500 square feet, with an 82-inch boiler, and a total weight of 232,200 pounds, while the Lehigh Valley compounds have 4,105 square feet, with an 80-inch boiler, and a total weight of 225,000 pounds. These figures are assembled, for convenience, in the following table:

COMPARISONS OF WEIGHTS AND HEATING SURFACES.

	D. & H. Co. L.	V. R. R.	I. C.	Union Ry
	Consolidation	Consolidation	Mastodon	Consolidation
Total Weight.....	176,000 lbs.	225,000	232,200	230,000 lbs.
Weight on Drivers.....	157,500	202,232	193,260	208,000 lbs.
Heating Surface				
Tubes.....	3,036.26 sq. ft.	3,890 sq. ft.	3,237 sq. ft.	3,116.5 sq. ft.
Heating Surface Firebox.....	312.28 sq. ft.	215 sq. ft.	263 sq. ft.	205 sq. ft.
Heating Surface Total.....	3,348.54 sq. ft.	4,105 sq. ft.	3,500 sq. ft.	3,322 sq. ft.
Tubes, Number.....	417	511	424	355
Tubes, Diameter.....	1 1/2 inch	2 inch	2 inch	2 1/4 in.
Tubes, Length.....	14 ft. 0 in.	14 ft. 7 3/4 in.	14 ft. 8 3/4 in.	15 ft. 0 in.

The firebox heating surface of the D. & H. engines is very large, and, we believe, larger than ever before used on a lo-

comotive. This will be advantageous with fine anthracite coal. The statement of these facts shows this design to be a notable one. The very large boiler capacity ought to give good account of itself in producing abundant steam and with very satisfactory economy. The table of dimensions follows:

General Dimensions.

Gage.....	4 ft. 8 1/2 in.
Fuel.....	Fine anthracite coal
Weight in working order.....	176,000 lbs.
Weight on drivers.....	157,500 lbs.
Wheel base, driving.....	16 ft.
Wheel base, rigid.....	16 ft.
Wheel base, total.....	24 ft. 2 in.

Cylinders.

Diameter of cylinders.....	22 in.
Stroke of piston.....	28 in.
Horizontal thickness of piston.....	5 1/2 in.
Diameter of piston rod.....	3 3/4 in.
Kind of piston packing.....	Cast iron
Size of steam ports.....	18 in. by 1 1/4 in.
Size of exhaust ports.....	18 in. by 2 1/4 in.
Size of bridges.....	1 1/2 in.

Valves.

Kind of slide valves.....	Richardson balanced
Greatest travel of slide valves.....	5 1/2 in.
Outside lap of slide valves.....	3/4 in.
Inside lap of slide valves.....	1 line and line
Lead of valves in full gear.....	Line and line F. & B.

Wheels, etc.

Diam. of driving wheels outside of tire.....	50 in.
Material of driving wheel centers.....	Cast steel
Tire held by.....	Shrinkage
Driving box material.....	Cast steel
Diam. and length of driving journals.....	9 in. diam. by 10 in.
Diam. and length of main crank pin journals (main side, 7 in. by 5 1/4 in.).....	6 1/2 in. diam. by 6 in.
Diam. and length of side rod crank pin journals (inter., 5 1/2 in. by 4 3/4 in.) F. & B.....	5 in. diam. by 3 3/4 in.
Engine truck, kind.....	2-wheel swing bolster
Engine truck journals.....	6 in. diam. by 10 in.
Diam. of engine truck wheels.....	30 in.
Kind of engine truck wheels.....	Steel tired spoke center

Boiler.

Style.....	Straight, with wide firebox
Outside diam. of first ring.....	74 in.
Working pressure.....	180 lbs.
Material of barrel and outside of firebox.....	Carbon steel
Thickness of plates in barrel and outside of firebox.....	3/4 in. by 9/16 in.
Firebox, length.....	120 in.
Firebox, width.....	108 in.
Firebox, depth.....	Front at center, 71 in.; back, 61 1/2 in.
Firebox, material.....	Carbon steel
Firebox plates, thickness.....	Sides, 3/4 in.; back, 3/4 in.; crown, 3/4 in.; tube sheet, 9/16 in.
Firebox, water space.....	Front, 3 1/2 in.; sides, 3 in.; back, 3 1/2 in.
Firebox, crown staying.....	Radial 1 in. diam.
Firebox stay bolts.....	3/4 in. by 1 in. diam.
Tubes, material.....	Charcoal iron No. 11
Tubes, number of.....	417
Tubes, diameter.....	2 in.
Tubes, length over tube sheets.....	14 ft.
Heating surface, tubes.....	3,036.26 sq. ft.
Heating surface, water tubes.....	86.75 sq. ft.
Heating surface, firebox.....	225.53 sq. ft.
Heating surface, total.....	3,348.54 sq. ft.
Grate surface.....	90.19 sq. ft.
Grate style.....	Water tubes, dead bars and drop bars
Ash pan, style.....	Hopper dampers front and back
Exhaust pipes.....	Double high
Exhaust nozzles.....	3 3/4 in., 3 1/2 in. and 3 in. diam.
Smoke stack, inside diameter.....	16 in.
Smoke stack top above rail.....	14 ft. 11 1/4 in.
Boiler supplied by.....	2 injectors, Nathan & Co. monitor

PROMISING ATTACK ON THE LOCOMOTIVE SMOKE PROBLEM.

It may be possible to entirely overcome the production of smoke by locomotives using smoky fuel. It is practicable to greatly reduce this evil and because information is necessary to the application of any improvement the recent action of the Western Railway Club in appointing an able committee on this question is promising and also commendable. Soft coal must be used to a large extent and often poor coal at that. There are many devices for which great advantages are urged and it may be possible to obtain marked improvements by their use. Greater care in firing will do its part and the probable extension of the use of large grates will also help. Careful consideration of the subject and a study of the conditions which result in the present difficulty cannot fail to lead railroads to do all that is in their power to obviate it, but it is a most difficult problem.

It has been demonstrated that soft coal may be burned in

proved firing. The activity of municipal smoke inspectors, and the natural desire to make travel more comfortable and to abate a nuisance, will lead to greater efforts to build new engines so that they will smoke as little as possible, and the evident tendency toward wider fireboxes with perhaps also the use of two fire-doors, where they may be put in, may be expected to help in this direction.

The committee is to investigate a very old subject, but this is believed to be the first important systematic, concerted attack on the question as concerns the locomotive. It is hoped that everyone having information or facts from experience will offer them to this committee, Messrs. G. R. Henderson, R. A. Smart, J. C. McMynn, R. D. Smith and J. W. Luttrell.

A LARGE SIX-COUPLED SWITCHING LOCOMOTIVE.

The Baldwin Locomotive Works have recently completed a very large switching locomotive for the Cambria Steel Co., and by the courtesy of the builders we show a photograph.



Powerful Switching Locomotive for the Cambria Steel Co.

Built by THE BALDWIN LOCOMOTIVE WORKS.

stationary practice with practically no smoke and with a gain rather than loss in efficiency. High furnace temperatures are necessary and there must be plenty of space for combustion, so that the gases shall not be brought into contact with the heating surfaces to be chilled before the combustion of the hydrocarbons is complete. The volatiles must be evolved slowly, and for this large grate areas are necessary and the coal must be fired in small quantities. It is also important that the air supply should be sufficient to combine with the volatiles as they form. It has been found very advantageous to divide the furnace into two parts so that one may be fired at a time and while one side is cooled by fresh coal the other side is at its highest temperature and is in condition to send hot gases to the bridge wall to mix with and consume the volatiles as they are given off most rapidly by the other side. Grates should have ample air spaces and means for keeping the bottom of the fire clean.

These are believed to be the conditions which are most likely to bring about the desired result in steam boiler practice of any kind, and as many as possible should be applied to the locomotive, but the limitations are rigid. It is possible to apply special furnaces to stationary plants and to obtain plenty of fire-box room, and the use of automatic stokers is easy, but when with all of these factors used to their best advantage the smoke is not altogether prevented, too much must not be expected from the locomotive with its extraordinary rates of combustion and the sudden and extremely great variations in the demands for steam.

Every road has a lot of old engines which present necessities have outgrown and yet representing a large investment. These present a special feature of the problem, which will not be reached by improvements in construction. This is probably the field for combustion devices, and also one for im-

This is the largest of its type that these works have produced, and we do not know of any other exceeding it. The general dimensions are as follows:

Cylinders.	
Diameter	21 in.
Stroke	26 in.
Valve	Balanced
Boiler.	
Diameter	68 in.
Thickness of sheets	11/16 in.
Working pressure	180 lbs.
Fuel	Soft coal
Firebox.	
Material	Steel
Length	108 1/2 in.
Width	42 in.
Depth, front	65 1/2 in.
Depth, back	62 1/2 in.
Thickness of sheets, sides	3/4 in.
Thickness of sheets, back	3/4 in.
Thickness of sheets, crown	3/4 in.
Thickness of sheets, tube	1/2 in.
Tubes.	
Number	323
Diameter	2 in.
Length	10 ft. 5 in.
Heating Surface.	
Firebox	169.7 sq. ft.
Tubes	1,738.3 sq. ft.
Total	1,908.0 sq. ft.
Grate area	31.57 sq. ft.
Driving Wheels.	
Diameter outside	50 in.
Diameter of centre	44 in.
Journals	9 in. by 12 in.
Wheel Base.	
Driving	11.0 ft.
Total engine	11 ft.
Total engine and tender	39 ft. 7 in.
Weight.	
On drivers	137,080 lbs.
Total engine	137,080 lbs.
Total engine and tender	218,000 lbs.
Tender:	
Diameter of wheels	30 in.
Journals	4 1/4 in. by 8 in.
Tank capacity	4,000 gals.
Weight empty	34,000 lbs.

COLUMBIAN ELECTRIC CAR LIGHTING SYSTEM.

A system of railroad car lighting by electricity, deriving the power from the axle, has been developed and improved by the Columbian Electric Car Lighting and Brake Company, 11 Broadway, New York. The features of the system are illustrated in the accompanying engravings.

The essentials of the system are the generator, a storage battery for furnishing current while the car is standing at stations, and the automatic devices for providing for the reversal of the direction of the motion of the generator and the regulating device for cutting out the generator at low speeds and for maintaining a constant voltage under varying speeds. The system is arranged so that the lamps take current from the generator at speeds above 20 miles per hour, and the surplus not needed for the lamps goes into the storage battery, which, in usual working, is always charged nearly or fully up to its capacity and is called on to furnish current only when the generator is cut out by the automatic switch. The system

differs from those which employ one battery for the lamps while a second battery is being charged by the generator, and in the Columbian system the battery is very seldom, if ever, fully discharged. In one case a battery was found ready to supply full voltage to the lamps after the car had been lying idle on a yard track for six months. In using but one set of accumulators in this way their capacity need not be large, which is an important item.

The generators are of the bipolar type, with shunt winding and steel magnetic circuits. They are enclosed in dust proof cases and are mounted on the trucks, as shown in Figs. 1 and 2, with a nose piece carried in a stirrup under the truck frame, while the chief portion of the weight comes upon the axle. The axle is fitted with a split sleeve, the ends of which are gripped to the axle by means of a form of chuck which permits of securing perfect centering of the sleeve and rigid connection to the axle whether it is rough or turned. Bearing rings running in grooves in the sleeve carry the generator. The end of one of the chucks appears at the left in Fig. 3. The

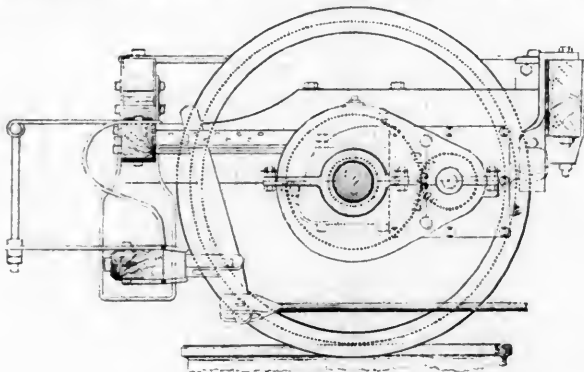


Fig. 1.

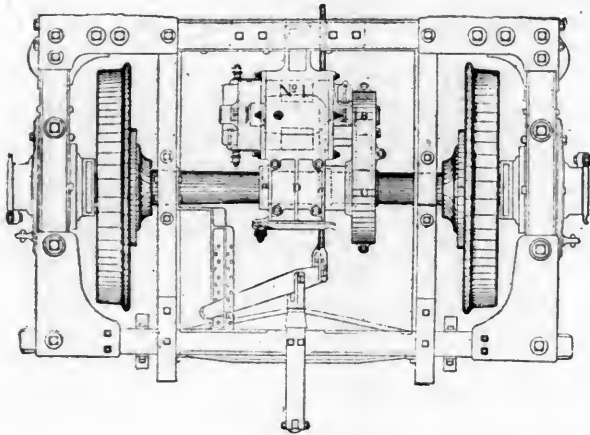


Fig. 2.

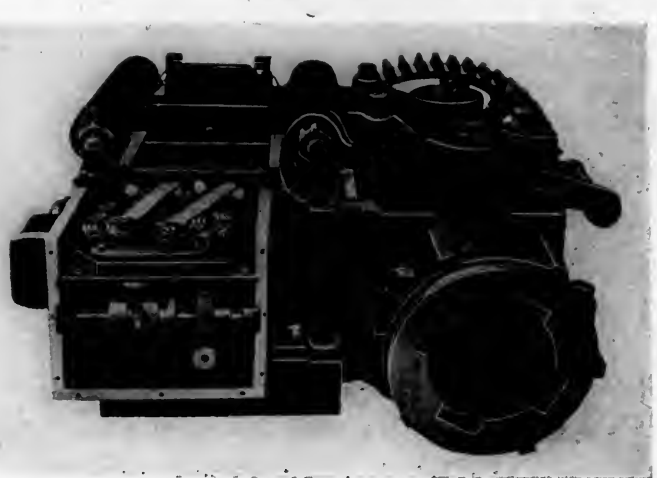


Fig. 4.

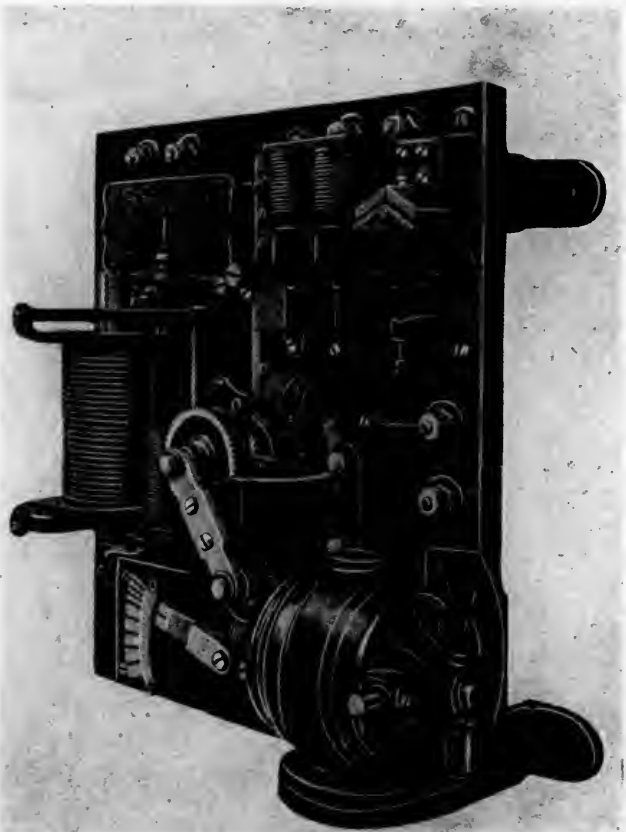


Fig. 5.

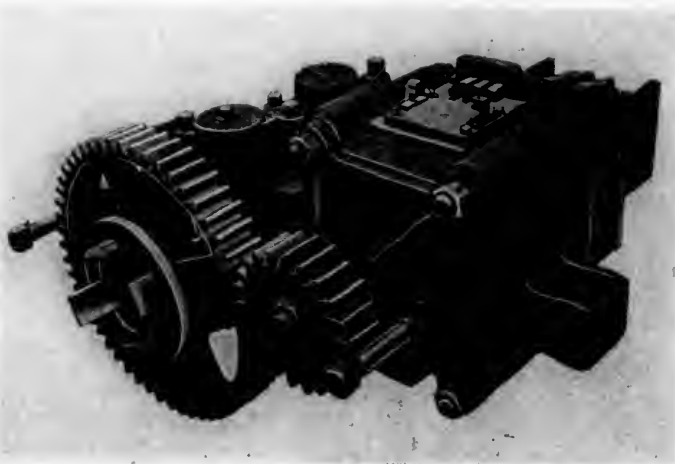


Fig. 3.

COLUMBIAN ELECTRIC CAR LIGHTING SYSTEM.

generator support at the sleeve is made by means of spring buffers, appearing on top of the axle in Figs. 3 and 4.

The ingenious pole changing device appears in Fig. 4. The end of the dynamo shaft carries a worm which drives a short horizontal shaft upon which a reverse, screw thread, cylindrical cam is mounted. The pole changing switch has six points and the direction of the current is changed upon the reversal of the direction of motion of the car by means of a pin which engages the cam thread below the switch. This pin is pressed into the slot in the cam by a spring, and the slot changes in depth in such a way as to throw the pin to the opposite end of the threaded slot upon the reversal of the direction of motion of the cam. This feature is shown in the photograph, but is obscured by the necessary reduction in the engraving. It is sufficient to say that the pole changing is accomplished mechanically without requiring any attention.

The regulating devices are assembled on a stand which is secured to a partition in a convenient part of the car. They accomplish two things. First, the cutting in of the generator when the required speed is reached, and second, the automatic regulation of the voltage, which is done by controlling the strength of the field. The cut out is controlled by the V-shaped switch shown in the upper right hand corner of Fig. 5. The switch is operated by double magnets, the lower pair of which are connected across the terminals of the armature and are shunt wound. The others are series wound and form a part of the circuit between the dynamo and the accumulators when the switch is closed. The voltage of the generator rises as the speed increases, when the train is started, and when it reaches the limit determined upon, the switch is closed. The voltage of the generator is then the same as that of the battery and the switch is held closed by the current from the generator to the battery. Upon the reduction of speed to the point at which the machine current can not balance that from the battery, the current reverses and the battery current permits the switch to open.

The regulation of the voltage in the lamp and battery circuits is obtained by aid of a small motor mounted at the lower right hand corner of the board (Fig. 5). This motor is always running and by means of worms and worm wheels it furnishes the power for moving the arm of the regulating rheostat. This arm is thrown into action with one or the other of two ratchets driven in opposite directions, the connection with the ratchets being controlled by a solenoid which is placed in the circuit between the generator and the battery. The rheostat controls the strength of the generator field. When the speed of the generator rises, tending to increase the voltage, the solenoid acts at once upon the rheostat, and it acts in a reverse direction upon a reduction of the voltage. The six-point rheostat at the lower left hand corner of Fig. 5 controls the resistance of the lamp circuit.

The following is a summary of the operation of the system. The train starts from a station with the main switch open and with no connection to the battery and no current through the solenoid. When the speed reaches 20 miles per hour, the limit generally used, the increased voltage closes the main switch and calls the solenoid into action. The armature of the solenoid then takes such a position as to cause the small motor to bring the arm of the rheostat into the proper position to bring the field resistance to the point required to secure the desired voltage, and it also places the necessary resistance in the lamp circuit to accommodate the increased voltage of the battery.

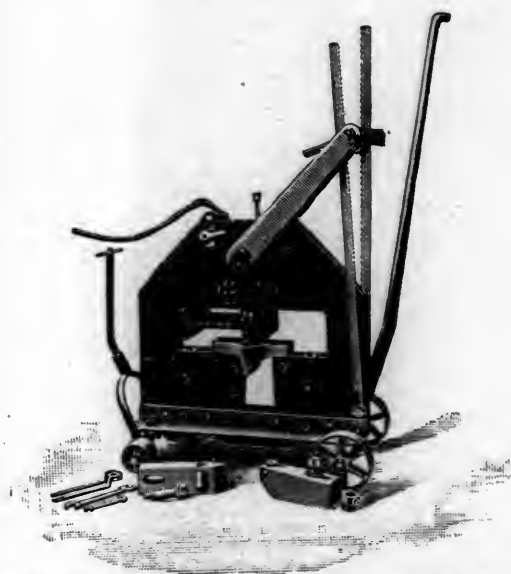
The car equipment of lamps and accumulators, and the adjustment of the machines, depends upon the requirements for lighting. The number of cells varies from 16 to 32, according to number of lights.

This system is now in use on a great many of the larger railroads of this country and Canada. The Columbia Co. have also put on the market, the Lindstrom Lever Brake, which is used successfully on several styles of passenger cars, and is now being introduced for use on freight cars, on account of its safety feature.

THE WERNER PORTABLE HAND POWER PUNCH.

A number of convenient and powerful hand punches and cutters for punching and shearing plates and structural shapes have been designed and are manufactured by Henry Pels & Co., at the "Berlin-Erfurt Machine Works," Berlin, Germany. This firm is represented in the United States by Arthur Koppel, 68 Broad street, New York.

All the machines are similar in construction and operation to the punch which is illustrated by the accompanying engraving. The frame of the punch is made of plates riveted together and mounted on wheels for easy removal about the work. The opening in the frame admits the piece to be punched and serves to secure the backing for holding the work from below. A saddle, shown in the engraving, is placed under the work for supporting a plate or I-beam when the web is to be punched. For punching the flange this saddle is removed and the upper flange is supported upon the shoes seen lying on the ground in front of the machine. These are slotted at their outer ends to receive bolts by which they are secured to the frame. The punch is held on a bar with a vertical motion in guides placed between the frame plates. The curved lever serves to raise and lower it quickly to and from the work. The punch is driven by an eccentric placed over the head of the punch bar, and this is turned by means of the heavy twin levers seen in the engraving. A wedge is placed between the



The Werner Portable Hand Power Punch and Shear.

eccentric and the punch bar when the punch is ready and the twin levers are brought down by degrees by means of the long lever at the right and one of the ratchet rods which engage pawls on the ends of the twin levers. The second ratchet rod is secured to the frame and serves to hold the twin levers while the hand lever is raised in preparation for a return stroke. The working of the hand lever drives the punch or the shear through its work, slowly, but effectually. The machine illustrated has an opening of 36 inches to receive the work. It weighs 2,200 pounds and exerts a punching pressure of 320,000 pounds. This is sufficient to drive a 2-inch punch through a plate $\frac{3}{4}$ inch thick. These machines have been in use in Europe for about two years, with very satisfactory results. They are particularly well adapted for railroad work.

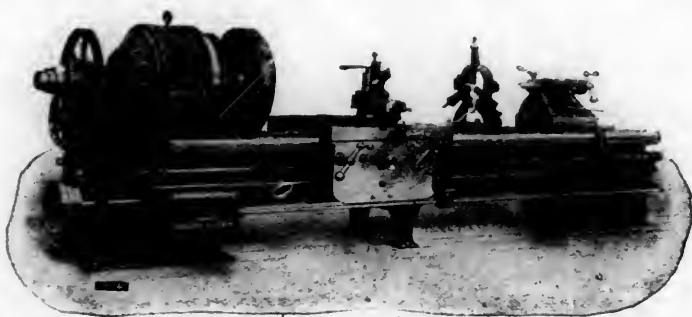
A \$300 endowment of a room and bed in the Brooks Memorial Hospital at Dunkirk, N. Y., has been provided for in an appropriation by the Central Railway Club. This is a precedent which will be sure to find hearty approval.

A MOTOR-DRIVEN LATHE.

The Bullock Electric Mfg. Co.

The accompanying engraving illustrates a 28-inch swing, screw-cutting engine lathe, made by Messrs. Schumacher & Boye of Cincinnati, Ohio, driven by a Bullock "Type N" motor. The motor is placed directly on the spindle in the head stock, in the place usually occupied by the cone pulleys and the armature spider is built directly upon the hollow spindle of the lathe. The arrangement is attractively compact. It does away with the countershaft and belting, leaving clear headroom for cranes and permits of running a single machine or a group of them for overtime work without running long lines of idle shafting and belts.

The control of the speed of the lathe is a strong recommendation of this plan. By means of a new system of variable speed control, the motor is given a greater range of speed, without loss of power, than is ordinarily obtained by the cone pulley. It has sixteen speeds, in either direction, including the back gear. The controller is placed upon the leg of the lathe, directly under the head stock, and is operated by a splined shaft running along the bed of the lathe, and a handle which



Bullock Type "N" Open Motor Direct Connected to 28-inch Schumacher & Boye Lathe.

travels with the carriage. The slowest speed is 60 and the highest is about 250 revolutions per minute.

These motors are the result of a great deal of experience, which has been applied to the design with special reference to the production of machines which shall not require the attention of experts. They run cool without sparking, although the variation of load may be the full capacity of the machine. The brush holder mechanism which has been a constant source of trouble and anxiety has in this case been developed into a simple and highly efficient form, which is stated by those who use them to give no trouble or anxiety. This brush holder is of the reaction type, which does not necessitate adjustment of the brushes, and when once set, the motor will operate in either direction without sparking and under all variations of load.

This type of motor lends itself particularly well to the conditions of direct driving of machines. The machines are compact and they are made with either open or closed ends, the latter arrangement rendering the motor moisture and dust proof, and adapting it to service wherein an open motor would not be practicable. The "Type N" motor is arranged to be placed upon the ceiling, on the side wall or floor, and it may be either belted, direct-connected or geared to the work.

The motor is fully described in Bulletin No. 2435, which may be obtained by addressing the Bullock Electric Mfg. Co., Cincinnati, Ohio.

Press dispatches state that the labor troubles at the Cramps' shipyards in Philadelphia have led to the decision to make very extensive use of pneumatic tools throughout the yards and shops. It is stated that contracts aggregating \$50,000 have been awarded to the Chicago Pneumatic Tool Co., for riveters, hammers, drills and other compressed air tools, and that much more will be expended in this way.

THE SARGENT COMPANY'S NEW WORKS.

The model steel and iron foundry which is being built by the Sargent Company at Chicago Heights, in order to increase their facilities, will be occupied about the first of January. The iron foundry department will be moved from the present works at 59th Street to the new plant, where it will have nearly three times the capacity, and will be devoted exclusively to the manufacture of brake shoes, while the old works will be entirely devoted to the manufacture of open-hearth steel castings. The new plant consists of two separate buildings, with floor space 80 by 200 feet each, and connected at one end by a building used as the finishing department. One building contains the iron foundry, while the other is devoted to small steel castings. These steel castings were formerly made in crucible steel, but will be made by the Tropenas process, which is now being used in several plants in each of the steel manufacturing countries of Europe. The present output of the Sargent Company is 600 tons of brake shoes and 600 tons of steel castings per month.

Mr. Edward Sweeley, Foreman of the car shop of the Pennsylvania Lines at Columbus, O., is to go to Logansport as Foreman of the machine shops.

Mr. George J. Hutz has been appointed Division Master Mechanic of the Illinois Central at East St. Louis, Ill., to succeed Mr. A. C. Beckwith, resigned.

Mr. M. M. Richey has resigned as General Superintendent of the Chicago, Lake Shore and Eastern to accept a position with the Central of New Jersey, with headquarters at Mauch Chunk, Pa.

M. F. Eagan, Jr., formerly Superintendent of Motive Power of the Union Pacific, Denver & Gulf Railroad, died Nov. 5, at his home in Chicago. Mr. Egan was in the service of the Union Pacific system for over 25 years.

Mr. L. H. Shepard has resigned his position as Mechanical Engineer of the Philadelphia & Reading, to enter the service of the Sterlingworth Railway Supply Company, as their representative, with headquarters at Easton, Pa.

The stationery department of the Burlington has been removed from St. Joseph to Hannibal and consolidated with the general supply department of the system at this point, under Mr. C. A. How, General Agent of the road.

Mr. George H. Colket of Philadelphia has been elected President of the Huntington & Broad Top Railroad Company, to fill the vacancy caused by the death of Spencer M. Jenney. Mr. Colket has been a director of this company since 1890 and is well qualified to assume the duties of President.

Horace S. Smith, formerly Vice-President of the Illinois Steel Company, died at his home in Chicago, Oct. 17, aged 73 years. He joined the Joliet Steel Company in 1875, and through his efforts the Illinois Steel Company was organized. Mr. Smith was elected to the position of Vice-President, which he held until ill health caused him to retire.

Mr. John P. Neff has been promoted to the position of Foreman of the Chicago and Northwestern, at Waseca, Minn., succeeding Mr. H. Montgomery, who has been assigned to other duties. Mr. Neff graduated from Purdue University in 1895, since which time he has been with the above company and engaged in important work in connection with the shops in Chicago and at other points. Mr. Neff was one of the observers in the tests on stacks and nozzles reported to the Master Mechanics' Association in 1896.

GILBERT'S GAGE GLASS PRESERVER.

The Gilbert self-packing gage glass preserver is made of rubber, in the form shown in the engraving, and is designed to permit of packing gage glasses so that they will be perfectly tight and prevent the breakage while in service. This packing is applied without the use of a wrench, and the gasket itself allows for sufficient expansion and contraction. The glass does not come into contact with metal, but bears against the rubber. The gaskets are made in six sizes, from $\frac{1}{2}$ to $1\frac{1}{4}$ inch. They are offered in confidence that they will greatly



Gilbert's Gage Glass Preserver.

reduce the breakage of glasses, which is a source of danger to enginemen and firemen. Another advantage of this device is the ability to pack gage glasses in fittings which are not perfectly in line, and make them tight without danger of breaking the glass. We have seen a number of statements by those who have used the gaskets expressing entire satisfaction with them, and prominent mention is made of the fact that the glasses are made tight by screwing the packing nuts down with the fingers. This is a recommendation which will be appreciated by every steam user. These gaskets are made and sold by R. F. Morse, 33 Eddy Street, Providence, R. I.

PNEUMATIC TOOL PATENT LITIGATION.

It is not strange that the rapidly increasing business in pneumatic tools should be accompanied by conflicts as to the rights covered by the important patents. Such a result has been foreseen, and we are not surprised to receive the following statement from the Chicago Pneumatic Tool Company of Chicago relating to past and impending litigation:

The Chicago Pneumatic Tool Company, manufacturers of the well-known Boyer pneumatic tools, scored an important victory last month in its patent litigation with the American Pneumatic Tool Company of New York. Between three and four years ago the American company brought suit at New Haven, Conn., against a concern which was using one of the Boyer tools, and succeeded in obtaining a preliminary injunction on the strength of an old decision it had obtained sustaining its patent in a prior suit which had not been strongly defended. Upon obtaining this preliminary injunction the American company sent every concern using Boyer tools a notice of infringement, in which it claimed some two millions of dollars damages against the users of Boyer tools. The Boyer people promptly took an appeal from the preliminary injunction order, and the order was reversed by the Court of Appeals at New York City. This was about three years ago, since which time the suit has been progressing toward a final hearing on its merits. It was argued at great length before Judge Townsend, in the United States court at New Haven, last June, and has been held under advisement by the court until last week, when Judge Townsend handed down an exhaustive opinion, holding with the Boyer people on every point and declaring that the Boyer tools did not infringe the American company's patent. The court also took occasion, in its opinion, to condemn the conduct of the complainant company in sending out the circulars above referred to for the purpose of scaring and intimidating purchasers of the Boyer tools.

During the years this litigation has been pending numerous competitors of the Boyer tools have sprung up, many of which are closely copied after the Boyer tools and are claimed by the Boyer people to be infringements of the Boyer patents. Having successfully defended themselves against the attacks upon their tools, the Boyer people now propose to turn their attention to infringements of their own patents, and on Saturday last began suit in the United States court at Chicago

against the Standard Pneumatic Tool Company, manufacturers of the "Little Giant" pneumatic tools. The Chicago Pneumatic Tool Company having been the pioneer in introducing pneumatic tools into railroad shops and metal working fields generally, and its Boyer tools having been the first successful tools for this work, is determined to protect the large business it has built up, and announces its intention of vigorously prosecuting all imitations of its Boyer tools and infringements of its patents.

An unusually large fill has been made on the Burlington. On the Deadwood, S. D., branch is a gulch 700 feet wide, known as Sheeps Canyon. This was crossed, until recently, by a wooden bridge, 126 feet high, which took over 240,000 feet of lumber in the building. Recently this trestle was filled in. It took twenty weeks to accomplish the task. It was necessary to haul 2,880,000 cubic feet of earth one and one-half miles up a two per cent. grade and unload off the high bridge. This required 1,486 trains of fifteen cars each; 22,000 carloads in all. The costly maintenance of the high trestle is saved and the serious danger of its destruction by fire avoided, thus warranting the expensive work.

Paper has found a new use in England in the manufacture of ropes for power transmission, and, contrary to what would naturally be expected, it seems to be very successful. "The Engineer" prints a description of paper ropes, and states that they are remarkably flexible and soft, seem to wear well and are satisfactory for purposes where specially high tensile strength is not necessary. They may be spliced and are composed of three main strands instead of four, as is customary in making cotton driving ropes. A case is cited in which a paper rope had been in continuous service for 18 months without perceptible wear, the surface being hard and shiny.

The pneumatic switch and signal system for the new southern union terminal station in Boston is supplied with compressed air by two stationary air compressors, and recently the adaptability of Westinghouse air-brake pumps for possible use in emergencies were determined by a test. Three locomotives were used and the air-brake pumps had no difficulty in supplying the pressure necessary to operate the plant.

BOOKS AND PAMPHLETS.

"Stories of the Railroad." By John A. Hill. Published by Doubleday & McClure Company, 141 East Twenty-fifth street, New York, 1899. Price, \$1.50.

Nine stories, some of which were written ten years ago, and all having appeared in the pages of "Locomotive Engineering" or the popular monthly magazines, have been brought together in this book, which has been so successful as to go at once into a second edition. The stories are of the railroad and railroad men. They take the reader into the work of the locomotive engineer and into his home and recreations and his love affairs. The author's knowledge of the life he describes was obtained in it as a fireman and engine runner in the West. There is always a fascination about railroad experiences when told in an entertaining way, and the popularity of this work is easily understood.

Heat and Heat-Engines. A Study of the Principles which underlie the Mechanical Engineering of a Power Plant. By F. R. Hutton, E. M., Ph. D., Professor of Mechanical Engineering of Columbia University. 553 pp., illustrated; cloth. New York: John Wiley & Sons. Price, \$5.

This book supplements an earlier one entitled "The Mechanical Engineering of Power Plants," by the same author, the object of which was to treat the steam engine and boiler with their accessories in such a way as to direct students to make use of them intelligently to meet the conditions of practical problems. That work did not consider the subject of design, this being left to the present one, the preface of which contains the following statement concerning its scope:

It discusses the energy resident in fuels, and the methods of its liberation as heat for power purposes; the transfer of such heat to convenient media whereby it can be used in heat-engines; the laws and properties of such media, and the design of cylinders of the necessary volume to give a desired mechanical effect or horse-power. Then, this point having been

reached, and relations being established for the mutual variations of temperature with pressure and volume in such media when operated in a cylinder with a piston, it becomes easy and natural to go further and discuss the air-compressor and its complement, the air-engine; and to extend this discussion to include the problem of mechanical refrigeration. The hot-air engine using a permanent gas as a medium naturally leads to the gas-engine and the oil-engine; and the engine using steam as a medium leads naturally to those using other media, such as naphtha, alcohol, and ammonia. The chapter on the Injector as a heat-absorbing and energy-transforming device closes the book.

The author undoubtedly desired to cover as much ground as possible in this work, which is commendable. The injector and mechanical refrigeration are interesting and important subjects, but they appear, however, to be a little out of place here, if we understand the author's purpose. The amount of space given to the various subjects attracts attention, and in future editions this may possibly be changed somewhat. For instance, 20 pages and 13 engravings are devoted to hot-air engines, and only four pages and three engravings to the steam turbine, which has every appearance of being one of the most important of recent improvements in steam engineering.

In these days of rapid progress in mechanical matters most text books are out of date almost immediately after coming from the press, and it is almost impossible to write a book that is up to date in which much attention is given to specific devices, because book-writing and publishing are slow processes.

The author's excellent presentation of the theory of heat in heat engines is commended. One needs the calculus to follow the text closely, but those, like the reviewer, who have become very rusty in its use, may read with comfort and understand the discussion. It has been recently said that "Thermodynamics is a subject to be approached only after a preparation of fasting and prayer, and then only in the hallowed seclusion of one's own closet." (We are not sure of the accuracy of this) but Professor Hutton has made it possible to get a better and clearer view of the subject than we have seen before, and he has robbed the dreaded "Thermo" of some of its terrors. The book contains much practical information concerning fuels, combustion and steam and gas engine accessories; and a fair proportion of space is given to such subjects as the draft of steam boilers, stability and structure of chimneys, gas making and fuels.

The book has many good points and will be exceedingly helpful to students of engineering. It has an admirable index.

Proceedings of the Master Car Builders' Association. Thirty-third Annual Convention, Held at Old Point Comfort, Va., June, 1899. Edited by the Secretary, Joseph W. Taylor, 667 The Rookery, Chicago. 511 pages, standard size (6 by 9 in.).

This volume contains the lists of conventions, of officers, subjects and committees for the next convention, list of members with their addresses, the constitution and by-laws and a complete official report of the proceedings of the 1899 convention, including the reports of committees, the discussions, the result of the letter ballot on important questions, and a set of drawings of the revised standards and recommended practices of the association. These reports come in so regularly and so soon after the conventions that they are now taken as a matter of course and receive little if any comment. They comprise the most valuable literature on car subjects and are unique in containing the beginning, the discussion and the definite conclusion of subjects of the greatest importance in the development of the transportation of the country. The report at hand emphasizes the clean character of the work of this organization, which met last June and now, through the activity of the Secretary, has completed the adoption of every suggestion of importance that was submitted for discussion, and those suggestions are now placed before the railroads as standards or recommended practices of the association for use on roads representing a car valuation of \$500,000,000. The association is not above criticism, but the impression of work carried out for a purpose and carried to completion which this report gives should not be lost. No new features are discovered in this volume except the changes made in accordance with the adopted recommendations with regard to revision of the former standards and the addition of new standards and recommended practices, which are very important this year. The volume appears somewhat later than the report of the Master Mechanics' Association, which is due to the letter ballots. In spite of this, the report comes more promptly than that of any technical association except the Master Mechanics'.

Jim Skeevers' Object Lessons on Railroad Engineering for Railroaders. By John A. Hill, President The American Machinist Press, and formerly one of the Editors of Locomotive Engineering. Published by The American Machinist Press, New York, 1899. Price \$1.00.

This is a book of twenty chapters, each of which is devoted to a question in the operation or maintenance of locomotives. The author writes from the standpoint of one who has devoted some years of his life to living and working with the men who operate and maintain the American locomotive, and he has chosen a unique method of bringing necessary improvements before those whom he desired to reach. These chapters appeared in the columns of Locomotive Engineering and in them the interesting character, Jim Skeevers, rises from locomotive runner to Superintendent of Motive Power. The object lessons are those which he teaches, some times to his fireman and at other times to the other officials, going as high as the Vice-President. The book is full of sensible discussions which may be read with profit by many railroad officers other than those having direct charge of locomotives. The same amount of information might have been given in other ways, but the author's idea was to attach the story to the argument in order to impress the lessons which he desired to teach. Nothing like this book has ever been printed before and the information is presented in a very entertaining way, not the least value of which is to show the utter absurdity of many features of the usual method of running a railroad. The book is full of slang and is probably true to life in this respect, but perhaps the author's object could not be secured in any other way. It contains many things that are worth remembering and we heartily commend it to our readers. Every motive power and operating officer ought to read it.

Notes on Mechanical Drawing. By Lucien E. Picolet, Instructor at the University of Pennsylvania.

In this little pamphlet the author has very carefully outlined the principles of mechanical drawings for the use of students in Mechanical Engineering at the University of Pennsylvania. He does not enter into detail, but rather sets forth the object, scope and methods to be carried out, in this course, which is as extensive and thorough as will be found in any of our technical institutions.

Cooking on Trains.—The Safety Car Heating and Lighting Co. have issued a handsome little booklet directing attention to recent improvements in Pintsch gas broilers used on parlor and buffet cars on the finest trains in the country. These devices have made it possible to obtain well cooked meats without the elaborate kitchen equipments of dining cars, and have been the means of greatly improving the meal service on buffet cars. These broilers are used on all of these cars on the New York, New Haven & Hartford, on such trains as the Empire State express of the New York Central, and the best trains of the Chicago & Northwestern and other equally important lines.

Westinghouse Railway Motors.—A pamphlet of 34 pages (6 by 9 in.) has been issued by the Westinghouse Electric & Manufacturing Co., Pittsburgh, devoted to the illustration and description of the railway motors manufactured by them and supplemented by several illustrations of typical Westinghouse railway power stations. The motors shown have all been subjected to the test of service operation. Attention is directed to the tendency of the past toward the use of motors having insufficient power and also to the importance of providing for the rise of temperature in the fields of motors of this type. Both of these points are provided for in the product of these works, and the ventilated armature has reached a high state of development. The use of laminated poles is continued. Their standard motors range in capacity from 20 to 150 horse-power, embodying the experience of the past 10 years. The engravings in this pamphlet are worthy of special note for their uniform excellence.

Transactions of the American Institute of Mining Engineers, Vol. XXVIII, February, 1898, to October, 1898, Inclusive.

This volume contains a list of officers and honorary members, a list of meetings, the rules and the proceedings, including papers and discussions of the annual meeting of the American Institute of Mining Engineers, held at Atlantic City in February, 1898, and the Buffalo meeting in October, 1898.

Wayside Notes Along the "Sunset Route."—The Southern Pacific Company has issued a number of exceedingly attractive pamphlets prepared by Mr. E. O. McCormic, Passenger Traffic Manager, and Mr. T. H. Goodman, General Passenger Agent, the best of which bears the title given above. The purpose of this pamphlet is to anticipate questions which the traveler desires to ask while he journeys. It is a guide book to the country passed through on the line of the Southern Pacific Company's "Sunset Route," and names the rivers and mountains and gives information concerning specially interesting scenes, giving facts such as altitudes and population, and pointing out many interesting places which would otherwise be passed by in ignorance of their existence. The traveler wants to be recommended to hotels and a part of the purpose of the pamphlet is to meet this requirement. The right hand half of every alternate page bears four well executed half-tone engravings. They are small but well photographed and well selected. The effect of an examination of it is to create a strong desire to see the places described, which is the test of a publication of this character. This is the best work of this kind that ever came into this office, and readers are recommended to secure copies.

"The Standard Scales." A copy of the fifth edition of the illustrated catalogue of scales, issued by the Standard Scale and Supply Company, 211 Wood street, Pittsburg, has been received. All who have occasion to use scales of any kind will do well to procure a copy. The variety of scales now regularly manufactured is surprising. We are told that the appearance of this catalogue is due to the large number of modifications of scales which increasing business has caused this company to manufacture. A specialty seems to have been made in weighing apparatus for railroads, for weighing coal, locomotives, cars and storehouse stock of various kinds. Among the special devices we notice on page 80 an illustrated description of the "Reed Recording Attachment," which seems to be a very convenient, simple and satisfactory device for obtaining a permanent record of the scale reading without stopping to note the position of the poise weight. A description of the attachment was printed in our November issue. Among the railroads using this device are the following: Chicago, Lake Shore & Eastern; Cape Fear & Yadkin Valley; New York, New Haven & Hartford; Southern; Louisville & Nashville; Great Northern; Long Island; Bellefonte Central; Pittsburg Junction, and the Alberta Railway & Coal Co. The appreciation of iron and steel manufacturers is shown by the fact that such concerns as the Midvale Steel Co., the Bethlehem Iron Co., the Lukens Iron & Steel Co., the Illinois Steel Co. and many others are using the device.

Ajax Products.—The Ajax Metal Co. of Philadelphia has issued a 32-page pamphlet describing Ajax productions and their uses. This firm manufactures six classes of specialties: I. Copper products for bearings, and including Ajax metal, red brass, yellow brass and acid metal. II. White metals; babbitts, solder, spelter, U. S. tin, Ajax tins and phosphor tin. III. Finished specialties, such as trolley wheels, trolley axles, contact pieces, controller fingers, Ajax Perfect rail bonds, armature motor and axle bearings. IV. Jewelers' specialties. V. Plat furnaces. VI. Ajax lead coated iron. The Ajax metal with which our readers are familiar is a composition of 77 parts of copper, 11½ parts of lead and 11½ parts of tin. It is an alloy prepared by a process developed by long study and experience which produces homogeneous distribution of the lead in such a way as to give support to the particles of this metal so that each will act as babbitt metal with a copper and tin shell. The important effect of this process was very clearly shown in the admirable paper by Mr. Guillian H. Clamer, read before the Franklin Institute and reproduced in our issue of September, 1898, page 313. This paper is printed in the pamphlet before us and is accompanied by information concerning bearing metals under the titles: "Phosphor Bronze Compared with Ajax Metal," "Ajax as Compared with Similar Compositions," and descriptions of the various bearing compositions known by the name "Ajax." The engravings of the pamphlet are excellent. They include half-tones of several high speed locomotives and one of the American liner "S. S. St. Louis," which is equipped throughout with Ajax metal bearings.

"Drawing Instruments." A catalogue and price list of drawing instruments has been received from Theo. Alteneder & Sons, 945 Ridge avenue, Philadelphia. This is the eighteenth edition of the catalogue of this well-known firm and it contains engravings, descriptions and prices of all of their instruments which are the results of fifty years of efforts to perfect their design and construction. An introductory chapter contains a history of drawing instruments of the American pattern, which began in 1849, when Mr. Theodore Alteneder introduced the improvements which have made the name of this firm a guarantee of excellence. The pamphlet has 114 pages, with an index.

"Pneumatic Tools." A catalogue of the "Monarch" pneumatic tools has been received from the Standard Railway Equipment Company of 210 Vine street, St. Louis, and 706 Great Northern Building, Chicago. The pamphlet illustrates the pneumatic hammers and portable drills manufactured and sold by this firm and their application to various kinds of locomotive and car building and repair work. The engravings are excellent half-tones, giving a clear idea of the construction and operation of the tools. The tools described are the "Monarch" pneumatic hammer and "Monarch" drills, for metal and wood. The piston air drill No. 1 will drill holes up to a diameter of 2¼ inches in metals. No. 2 is for wood boring and will bore holes up to 2½ inches diameter in oak. No. 3 will bore holes up to 1½ inches in oak, and the piston air drill No. 4 will drill holes up to 1½ inches in metals. The machines are light in weight and convenient in size.

"Improved Machine Tools." Messrs. William Sellers & Co. of Philadelphia have issued a new catalogue and general description of improved machine tools for metal working as designed and manufactured by them. The product of these works is so well known that it is not necessary to enumerate the various lines of machines. It is sufficient to say that the entire field of machine tool construction is represented and that anyone desiring machinery for metal working will find his needs provided for, and the engineering department in which the designs have been produced is constantly engaged upon the work of improvement in the regular product as well as upon the details of special construction which are required to meet individual conditions. The works are continually developing new machines and the present catalogue could not be complete for this reason. It includes as many as possible of the machines which have been added to the list since the appearance of the previous catalogue and those shown have in many cases been revised and improved upon former standards. This volume is intended to indicate the general line of work of these builders and it accomplishes this object admirably. If, however, intending purchasers do not find their requirements provided for in the machines which are illustrated, they may find that the concern has exactly what is wanted in the large number of machines which are not included. The needs of railroad and locomotive building shops have been studied with great care in many special tools. The lines of tools indicate that the designers have in mind the principles of low cost of manufacture by use of their machines because a large number arranged for multiple working are included. Testing machines of the Emery type, large cranes and locomotive turntables indicate some of the specialties which the company is prepared to supply. We do not attempt to give the whole list, but it may justly be said that this is a most excellent treatise on up-to-date machine tool construction, in which the engravings are uniformly excellent and the text gives a generous amount of information of the sort required by a prospective purchaser. The book represents the best construction of machines from small bolt and nut screwing machines up to eight-foot turning and boring lathes for 16-inch cannon and rotary planers for armor plate. The catalogue is every way creditable to the leading machine tool builders of this country.

Architect's Hand Book On Cements. By William W. Clarke & Son.

This little book of 96 pages contains a collection in convenient form of information concerning the proper use of cements, and gives a number of specifications and formulas for mixing and using cements as recommended by leading authorities. It includes the history of cements in brief, discussions of mixing, testing, the selection of sand, notes on cement concrete, sidewalks and floors, and a short list of books on cements and concrete. The latter half of the pamphlet is devoted to advertising. The address of Wm. W. Clarke & Son is 115 Gay Street, S., Baltimore, Md.

Mr. G. J. Fisher has resigned as Purchasing Agent of the Fitchburg Railroad.

C. F. Hettler, Purchasing Agent of the Pennsylvania Lines, at Fort Wayne, Ind., died in that city November 6.

Mr. Robert T. Lincoln, heretofore Chairman of the Executive Committee of the Pullman Palace Car Company, has been elected President, and Mr. T. H. Wickes was re-elected Vice-President.

Mr. J. B. Laurie has been appointed Purchasing Agent and General Storekeeper of the Central Vermont, with headquarters at Saint Albans, Vt., to take the place of Mr. W. B. Hatch, whose title was General Purchasing Agent.

Spencer M. Jenny, President of the Huntington & Broad Top Mountain Railroad, died very unexpectedly, Oct. 21, at his home in Philadelphia, of heart failure. Mr. Jenny was 61 years old, had been President of the above road since April, 1890, and was also a director of the Choctaw, Oklahoma & Gulf Railroad and of various financial concerns.

Mr. George R. Brown, for many years General Superintendent of the Fall Brook Railway prior to the transfer of the company to the New York Central, has been elected Second Vice-President and General Manager of the New York & Pennsylvania, a road running south from Canisteo, N. Y., into Pennsylvania. Mr. Brown was the originator of the "Brown's Discipline" and author of the article "Discipline and Education of Railway Employees," "American Engineer," February, 1899.

EQUIPMENT AND MANUFACTURING NOTES.

Electric headlights have been adopted on the Chicago, Burlington & Quincy for the fast mail and the Denver limited trains.

The Q & C Co. inform us that Mr. E. W. Hodgkins has sailed for an extended trip through Europe in their interests. Mr. J. K. Lencke, who has been abroad for this firm since January 1, has been recalled and is no longer in their employ.

The Baltimore & Ohio Railroad will have 62 new compound consolidated freight locomotives by the last of January. Fifty were ordered in September from the Baldwin Locomotive Works and the order has just been increased by 12 more.

The International Correspondence Schools of Scranton are making use of stereopticons in two of their instruction cars for the assistance of students in the railroad courses. The lectures are given by Mr. A. C. Beckwith, who was formerly Master Mechanic of the Illinois Central at St. Louis and who has taken charge of this branch of the work of the schools.

The Union Boiler Tube Cleaner Co., 253 Penn Ave., Pittsburgh, have just completed a contract for cleaning two Hazelton, or porcupine, boilers having 2,000 tubes, one end of each tube being welded tight. These tubes were badly scaled and the cleaning of the closed end required a special tool of unique design. The work also required the use of the special flexible shaft designed by this firm, which is the only concern in this country properly equipped with apparatus and expert operators for doing such work quickly, effectively and cheaply.

The Bullock Electric Mfg. Co. report 55 orders for the month of October, the machines ranging in size from the smallest to 300 kw. capacity. A repeated order was received from the Maryland Steel Co. of Sparrows Point, Md., this making the fifth order and being for a 300 kw. generator and several motors. Orders were received from the London (England) "Star" and St. Petersburg (Russia) "Novia Wremia," two of the most important papers of the respective cities, for the Bullock

"Teaser" equipment for operating newspaper presses. Two 300 kw. alternating current generators were shipped to the Wilson Aluminum Co. of Holcombe Rock, W. Va., to be used in the manufacture of ferro-chrome, an electro-chemical product used in the manufacture of chrome steel.

The Cling-Surface Manufacturing Co., of Buffalo, N. Y., report steadily advancing demand from belt users for "Cling-Surface," including several large shipments to Mexico and England. Unsolicited testimonial letters are being received every day from customers of this concern, one of which from Adams & Westlake Co., of Chicago, says: "We have been using Cling-Surface for some time and it gives perfect satisfaction." The Erie R. R. Co., Union Dry Dock, of Buffalo, said on March 2, 1896: "Our power has been increased very considerably, the belts are soft, pliable and in simply perfect condition; it has earned many times its cost." On Oct. 20, 1899, they again say: "We have not a tight belt in the shop, and are better satisfied than ever with Cling-Surface."

Announcement is made of the organization of the New York Air Compressor Company under the laws of the State of New Jersey. The capital stock of the company is \$100,000, and a complete foundry and machine shop plant has been purchased on the line of the New York & Greenwood Lake Railroad at Arlington, N. J. Contracts have already been let for a complete modern equipment of tools. It is intended to manufacture a complete line of air compressing machinery at the new plant. The officers of the company are: J. W. Duntley, President; Alexander MacKay, Vice-President; W. P. Pressinger, Secretary and Treasurer. The directors are: J. W. Duntley, Alexander MacKay, W. P. Pressinger, William B. Albright, W. O. Duntley, Thomas Aldcorn and Austin E. Pressinger. The New York offices of the company are at 120 Liberty Street.

An interesting statement in regard to the use of Pearson jacks comes from Mr. F. E. Paradis, Chief Engineer Chicago Terminal Transfer R. R., as follows: "We used eight of these jacks in connection with other jacks, in moving our 600 ton drawbridge. We used Pearson jacks exclusively to start the bridge on the ways, and used them at various points on the structure in raising and lowering it. While the bridge was being lowered, on account of the carelessness on the part of the man who was operating one of the Pearson jacks, the thread ran in, thereby closing the two ends tightly against the center. It was not noticed until the jacks around it had been lowered considerable, and bound the Pearson jack fast. We then placed four 35 ton hydraulic jacks at four points around the Pearson jack and attempted to release the load upon it, but were unable to do so. If each of the hydraulic jacks were lifting their full capacity, and I have every reason to believe that they were lifting more than their stated capacity, there was at least 150 tons on this jack. It seemed impossible to release it, and I gave instructions that the jack be broken with sledges. After hammering on it for some time it was found impossible to break it. It was necessary to cut the blocking out from underneath by a small piece at a time to release it." These jacks were furnished by the Pearson Jack Co., 64 Federal St., Boston, Mass.

The Pennsylvania Railroad has ordered 80 new locomotives to be built at the Juniata shops. Of these, 43 are Class G 4-A and 27 Class G 4. These classes are freight moguls, the former having 68-inch and the latter 62-inch driving wheels; otherwise the designs are alike. They will have Belpaire boilers with 356 flues, 2,814 square feet of heating surface and 30.8 square feet of grate area, and will carry a steam pressure of 225 pounds per square inch. The cylinders are 20 by 28 inches and arranged like those of the H 5 and H 6 engines illustrated in our June issue of the current volume, the cylinders being separate from the saddles. This practice appears to be likely to become standard on this road for the reasons stated in the description mentioned. The front frames are of cast steel and made in the form of slabs. The engines will have single steam pipes, like the Class E 1 passenger engine. These types are new and these are the first to be constructed.

Since the above was written, information has been received to the effect that the order had been increased to 113 locomotives, of which 35 will be Class G-4; 55, Class G 4-A; 13, Class L, and 10, Class H-6.

